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GOLDEN NETTED-LEAVED ORCHIDS.

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(*With a Coloured Plate.*)

In the year 1836 the collection of orchids at the Royal Gardens, Kew, was enriched with specimens of a genus which, till then, was practically unknown to cultivators, and the name of which is *Anæctochilus setaceus*. This plant came from Ceylon, and was regarded by botanists and cultivators as the most remarkable example of natural colouring which, up to that date, had been seen in English gardens. Among collectors of rare, curious, and beautiful plants, there soon sprang up a spirited competition for possession of examples of this costly gem. Botanical travellers and the spirited trading firms by whom the majority of plants collected are sent out, were stimulated to use every exertion likely to tend to the importation of such plants, and the result has been a constant accession to our lists of cultivated plants, of species and varieties of the same genus, so that now a good collection of Anæctochili constitutes a most important feature in a plant-stove. The reason of the interest taken in these plants is the beauty of their leaves. They are not uninteresting as flowering plants, and were the leaves less attractive than they are, a few would probably be cultivated for the sake of their pretty and comparatively simple flowers. As the case stands, however, very few cultivators care whether they flower or not; many have never seen them flower; and some forbid them to flower by nipping out the spike as soon as it appears; and on the other hand, the intense admiration which prevails for their wonderful leaves causes such an activity in propagating the plants that some of the species have scarcely yet had an opportunity for the development of their flowers. If any

reader, unlearned in botany and horticulture, desires to know something of the nature of the claim these plants have upon the admiration of the connoisseur, the accompanying plate will explain it better than pages filled with description and eulogy. It may be said, however, that eulogy in this case is impossible. No picture, no description, no perfervid expressions of surprise, delight, or even of admiration, bordering on worship, can convey an adequate idea of the extraordinary beauty of these plants. They are of humble growth, averaging from two to six inches in height, and may be described as perennial herbs. The majority have a distinct, fleshy stem, neat ovate or lanceolate leaves, fleshy leaf-stalks, and their roots proceed direct from the base of the stem, without any intermediate bulb, as in the majority of orchids.

Considered irrespective of their colours, these plants are remarkably neat, and have a character all their own. If the wonderful tracery of their leaves was all washed out, we should still be compelled to admire them for their graceful attitudes, their unassuming elegance, and the beautiful harmony of their proportions. But with these good qualities, they present us with a comment, all unthought of by the poet, who framed the question, "Who can paint like Nature?" In all the families of plants, so various in forms and colours, sometimes so gorgeous that they rival sunsets and repeat rainbows, there are no examples of colouring known which can be fairly said to divide with these the praise of being most wonderful and most perfect.

Usually the leaf appears as if formed of the richest purple, green, or olive-coloured velvet, or glossy satin or silk. Over this groundwork is spread an elaborate reticulation of gold or silver threads, the veining of the leaf being marked out as distinctly as if wrought in real metal of the most cunning workmanship; and, unlike the picture before us—which is the best that can be done by art of man—the gold has the lustre of gold, and the velvet the softness, and iridescence, and "touch me not" delicacy of velvet, and the whole thing is so wonderful that though we may have been familiar with the plants for years, we have never yet become thoroughly convinced of their reality. Those can best believe them to be real who have made fortunes by trading in them. The amateur who keeps them for his enjoyment solely may be permitted to dream on and persist in their unreality, and if there is no wild eastern legend of angels having lost their wings when engaged in missions of mercy in the Indian Archipelago, or of some fragments of the jewellery of heaven having been let fall to give human creatures an idea of the material equivalents of spiritual perfections; if there are no

such legends there ought to be, and the writer of this lives in hope of some day discovering that these plants are as deeply rooted in the fertile soil of Oriental poetry as in the hearts of those amateurs who regard them as the most precious of all their phytological treasures.

There is a consideration always present to the mind of the present writer, and it is this: that the most wonderful of plants are weeds somewhere. Orchids that sell for fifty or a hundred guineas each in this country exist somewhere in countless thousands, and grow and bloom with rampant strength amongst the rubbish of tropical swamps and forests, making paradises of colour and fragrance for themselves alone, and for the few wild creatures that keep them company. So with the species of Anæctochilus, which travellers tell us are hedgerow weeds in Ceylon, wildings of the waste in Borneo and Java, rarities of almost priceless value with us, yet scattered as profusely amongst the damp shady woods, and amongst caverns and swamps in the hotter parts of the East as chickweed, and crane's-bills, and primulas are in all the waste places of our own land. *A. setaceus* is reported to be known as the "king of the woods" by the Cingalese, who of necessity appreciate its beauty, and only value it less than we because it is common of the commonplace, and where it grows they tread on rubies, pearls, topazes, and velvet, and gold and silver lace.

Cultivators of these plants have a constant source of interest and curiosity in the difficulties that have hitherto attended the keeping and increasing their specimens. The gorgeous colouring of these plants suggests a difficulty in cultivating them, and accordingly many failures have occurred where there has been no lack of enthusiasm or of appreciation of their beauty. It has been the fate of nearly all the species of orchids introduced to this country to be overdone with heat and moisture, and killed with too much care. The Anæctochili have shared in these calamities. They have been stewed, starved, roasted, and stifled, and they have disappeared from the scene they were intended to enliven often enough to justify a few remarks here upon the true principles and routine of cultivation. I have seen a great many good and bad collections, and have noticed the effects of various kinds of treatment, and the result is that I believe very few private growers have as yet become fully aware of the capabilities of the plants for the decoration of orchid houses, or of their marvellous individual beauties. The common failing is too much heat, and too close and steaming an atmosphere, conditions which debilitate the plant, diminish the brilliancy of its colouring, render it tall and spindling when it ought to be short and sturdy and robust, and sometimes cause its death at the very mo-

ment when it ought to be in full perfection. What is called "cool treatment" must, however, not be attempted, though Mr. Lowe, in his *Beautiful Leaved Plants*, tells of a specimen of the lovely *A. xanthophyllus*, which was kept in a greenhouse, shaded by a tent of paper, where the temperature frequently fell to 35° during November and December, yet the plant was always in perfect health, and lost none of its leaves. Shade and warmth are indispensable. During the winter the night temperature may descend to 50° with perfect safety, but a good average is 55°, and the average day temperature should be 60° to 70°, the last-named being the rise allowed during sunshine. After March the plants begin to grow vigorously if properly treated, and the temperature should rise to an average of 65° at night, with 60° for the minimum and 70° for the maximum, and during the day they will enjoy a heat of 70° to 90°, the best average being 75°.

During the growing season water must be given plentifully at the roots, but *not a drop must touch the leaves*, a rule to be strictly observed in the cultivation of all delicate plants that have got pilose leaves, such as Begonias, Cyanophyllums, Sphærogynes, etc. In winter, also, they must have water enough to keep the roots always moist, but great care must be taken not to give them too much, or disease will be the consequence. On the other hand, drought is death to them. Sunshine is decidedly injurious, but they need plenty of light when grown under glass, and on that point a special remark must be made presently. They make but few roots, and must always be grown in small pots; the best soil is chopped sphagnum; all mixtures of peat, loam, and leaf-mould, as recommended by persons who have never grown these plants, or who have grown them badly, are objectionable. The sphagnum should first be scalded, then chopped fine, and mixed with an equal bulk of silver sand and broken pots of the size of peas. The pots should be quite clean, and should be half filled with crocks, over the crocks some unchopped sphagnum, and then the mixture heaped up in a convex form above the level of the rim of the pot. In fixing the plant, a little pure sand had best be used to fill in next the collar, both to prevent bruising the stem and also to support it more firmly. One or two small pieces of stick are generally requisite to support the plant until it has made fresh roots. In any case of a plant appearing unhealthy, the best course is to remove the soil carefully from the roots and repot it afresh, and encourage it to make fresh roots. After being newly potted, it is best to place them in close cases, or under bell-glasses, for about a fortnight, after which it is certainly better to expose

them to the general air of the stove, than to keep them constantly under dell-glasses.

Opinions and practices differ on this point. Mr. B. S. Williams, of Victoria Nursery, Holloway, is one of the most successful cultivators of these lovely plants, and he prefers bell-glasses, but is very particular to have them removed occasionally and wiped dry, so that there is not for any length of time a stagnant moisture in contact with the leaves. This practice prevails largely. But I have seen some very good collections in perfect health, where bell-glasses were used only on occasions of repotting and dividing the plants, when they certainly render an important service. I shall not soon forget the beautiful examples in the East India Orchid House, at Pine Apple Nursery, Edgeware Road, where Mr. A. Henderson follows the system I am recommending of exposing them to the common atmosphere of the house, which of course is free from draughts, always moist, and the temperature properly regulated for these and other inmates. The advantages of abolishing glasses are many. In the first place, the plants are seen in all their splendour as components of the general display. When glasses are used, they form no part of the display, and we only see them when making a special investigation of them. Another advantage is that they bear a higher temperature without injury, and are not so soon stewed to death as when shut in close with an excess of moisture about them. A third advantage is saving of expense and trouble, two items of least importance in this case, because growers of Anæctochili are not usually sparing of either. Nevertheless, a saving is a saving, and it deserves mention. When the cultivation is attempted in a warm greenhouse—and an ardent admirer of these plants, having no other convenience, may certainly try a few with a fair prospect of success—bell-glasses or a box with glass top must be used, both to protect them from draughts and from too arid an atmosphere. If opinions are divided on this point, there will be no demur to the proposition that they should not have bottom-heat. If the general temperature of the house is right, then all is right in that respect, and bottom-heat is neither necessary nor desirable.

There is another point of importance, of great importance indeed to the botanico-cultivator. It is this, that it benefits the plants to allow them to flower. The general opinion is that the flowers should be nipped out, in order to throw all the vigour of the plant into the leaves, that the leaves may be fully developed, that they may have their proper lustre and richness of painting. Well, the consequence is that an immense number of plants have been lost, through not being allowed to bloom, and much enjoyment has been lost also for the

flowers are at least pretty, if they are quite outdone in glory by the leaves. We have yet much to learn of the extent to which plants may with impunity be denuded of their flower-buds, or have their seminal germs suppressed; in many cases the vigour of the leaf is visibly increased, in others it is not so, and many plants have no doubt been lost to cultivation by a mistaken interference with nature's order of procedure. In the case before us, it may be stated without hesitation, that it is good for the plants to flower, and the cultivator should hail the flowers with a welcome.

The Anæctochilus belongs to the *Neottieæ* section of Orchidaceæ. The genera of this section are characterized by having powdery pollen, a dorsal anther, almost parallel with the stigma, or with the face of the column. For congeners they have but few important genera. We find in this section the interesting *Prescottia*, our British *Listera* and *Neottia* and *Epipactis*, the beautiful *Spiranthes*, the chaste *Goodyera*, also renowned for the beauty of its leaves, and these are about all that are of much interest to cultivators out of the eighty established genera, of which the section consists. The principal characteristic of the flower of Anæctochilus is the spreading apex of the lip, from which it takes its name. The flowers are usually white, produced in light, graceful, rather sparsely furnished spikes, and they may well be likened in general appearence to the flowers of the pretty "mother of thousands," *Saxifraga sarmentosa*, which is a good substitute for an orchid in a poor man's garden, and is less often seen in a flowering state than it should be.

Considering the activity of plant collectors, and the botanical wealth of the regions whence the Anæctochili at present known have been obtained, it is fair to anticipate that in a few years there will be hundreds of species known to science. At present the species in cultivation number about thirty, and the following are the most notable for their distinctness and beauty:—

A. argenteus grows to a height of four inches; leaves large, light green, with sharp lines of bright silver. Easily grown, and if warm enough never requires a bell-glass.

A. argyreus. A Brazilian species, with long, narrow green leaves, marked with silvery lines, the central space between the lines greyish.

A. Bullenii grows six inches high; leaves large, bronzy green, with three broad lines of coppery red, which occasionally change to bright gold. Difficult to grow, and requires a bell-glass.

A. Dominii. A hybrid between *Goodyera discolor* and *A. xanthophyllus*, obtained by Mr. Dominy, principal cultivator

at Messrs. Veitch's establishment, and the greatest hybridist of modern times. The leaves are dark olive green, with a pale coppery tinge down the centre, the main ribs marked out by fine pallid lines, and connected by means of light reticulations.

A. El Dorado. Useless and unattractive, except in the hands of the most expert cultivators. It is deciduous, the leaves dark green, with light tracery.

A. intermedia grows three inches high; one of the most beautiful and easily grown, it does not need a bell-glass. Colour, dark olive striped with gold. Deliciously silky and the habit very fine.

A. Javanicus grows four inches high; leaves olive green, blotched with light green; suitable only for large collections.

A. Lobbii grows three inches high; leaves large, dark olive, with elegant light markings; a fine species.

A. Lowii. The largest of the genus and one of the grandest, grows seven or eight inches high, with oval acuminated leaves four or five inches long and three broad, the ground colour a solemn purplish bronze with longitudinal veins of bright gold, connected together by transverse reticulations. The most easy to cultivate of any. It is probably the loveliest of all known plants on the face of the earth.

A. maculatus grows five inches high; leaves marked with frosted silver in the centre, and with margin of rich dark green. A fine species, and easy to grow.

A. Nevilleanus grows three inches; leaves dark olive, blotched with orange; difficult to grow.

A. petola grows four inches; leaves light and velvety, with bands of deep gold. A very fine species, and easy to grow.

A. quercetcolus grows four inches; colour light green, with white blotches. Grows freely, but not desirable in small collections.

A. Roxburghii grows three inches high; leaves dark, velvety, superbly veined with lustrous silver. There are several kinds in cultivation with this name. The true Roxburghii is superb, and rather difficult to keep in good condition.

A. Ruckerii grows four inches high; leaves broadly ovate, ground bronzy green, with six rows of spots extending the entire length of the leaf. Very distinct and fine; rather difficult to manage.

A. rubro-venia. Sometimes classed with Goodyera, but not justifiably so. Grows four inches high, has beautiful ovate leaves of a blackish green colour, marked with sharp longitudinal lines of reddish crimson extending their whole length.

A. setaceus. A very fine species. Grows four inches high;

leaves velvety, the ground colour a dull mixture of olive and chocolate, with sharp longitudinal veins and connecting reticulations, all of the most refulgent gold. The leaf of this glorious plant probably approaches nearest in resemblance to some exquisite work of human art of any natural production, the leaf appearing to be wrought in the richest velvet, and most delicate and cunning golden filagree work. Under the microscope the veins have a strong red hue, and their beauty is such that any attempt at description would be ridiculous. It grows well, but requires great care, especially to preserve the leaves from excess of moisture. There are several varieties, and all are good.

A. striatus. A pretty slender species, growing five inches high. Leaves ovate-lanceolate, bright cheerful green, with shades of purple and bronze, and a broad, bold rose and white stripe down the centre; grows well, and does not need a glass.

A. Turneri. Recently introduced by Mr. B. S. Williams, and named in honour of J. A. Turner, Esq., of Manchester. It has a stout robust habit, leaves broadly ovate, colour rich bronze, freely marked by golden and coppery reticulations. A superb species, apparently quite easy to manage.

A. Veitchii grows six inches high; leaves large, light green, richly reticulated all over with sharply defined lines. Grows freely, and does not require a bell-glass.

A. xanthophyllus grows five or six inches high; leaves ovate; ground colour deep purplish brown, and of the richest velvety texture; in the centre a broad lenticular band of yellowish green, extending from the base to the point; longitudinal lines of refulgent gold connected by reticulations of the same colour. A splendid and distinct species. Grows freely, and may be easily managed.

ON MUD VOLCANOES AND SALT LAKES IN THE CRIMEA.

BY PROFESSOR D. T. ANSTED, M.A., F.R.S.

A RECENT visit to the eastern part of the Crimea, and the flanks of the Caucasus, and a previous acquaintance with part of the Carpathian chain, have suggested to me a relation of some importance between mud volcanoes, volcanic eruptions of the ordinary kind, and the form of large tracts of land elevated above the water level. The following remarks, founded on these observations, are partly descriptive and partly practical, as referring to economic products. The phenomena of mud volcanoes have not perhaps attracted that amount of attention that seems due to their great extent, wide range, and general parallelism with lines of elevation on a large scale.

The form and extent of land of the old world may be said to depend on certain grand physical facts outlined in the mountain chains. Excluding those mountain chains, which, from the complete denudation they have undergone, may be regarded as of very ancient date—chains in which the only really igneous rocks are now greenstones, and of which only the hard metamorphic and crystalline rocks remain, it is not difficult to define the line of elevation or general axis along which upheaving forces have acted on the largest scale. In the old world this line or axis is distinctly double, and an important space is contained between the two axes. Thus the northern axis, commencing with the Pyrenees, is continued by the main chain of the Alps and the Carpathian mountains, connects by the Crimean chain with the Caucasus, and by that again with the Hindu Koosh and the mountains of the north of China. The southern line commences with the Atlas mountains, and runs on, though not without interruptions, by the mountains of Ethiopia and Arabia to the vast culminating mountains of the Himalayan range. Approaching the Pacific, the mountain line or axis of elevation becomes north and south, corresponding with and meeting that of the great American continent.

But between these two main lines of mountain, which consists chiefly of stratified rocks, either entirely masked or only partially metamorphosed, there exists a number of districts, having the same general direction, remarkable for volcanoes or for volcanic rocks of comparatively recent date. Among the volcanoes, some few, as Etna and Vesuvius, are active; others, as Mount Ararat and some of the highest of the anti-Taurus chain, are exceeding lofty, and are now not erupting, but have been in activity during the later tertiary period. In many

places there are no volcanoes, but abundant stores of basalt and other igneous rock. But the main point for consideration is the fact that along the whole space between the north and south axis, as marked by the presence of lofty mountain chains, and principally towards the northern of the two chains, volcanic eruptions of comparatively modern date have taken place, while on the other hand there are but few and slight indications of this kind in the great plains to the north or south of the lines of elevation.

While active volcanoes are comparatively rare within the great area here alluded to, there is no want of an inferior kind of activity, proving that at a very moderate depth below the surface there are still many connecting links, though perhaps of a somewhat obscure kind. Earthquakes may be regarded as among these links, but mud volcanoes are the most manifest and direct. Sulphur springs or springs of water charged with sulphur, and sulphuretted hydrogen gas, and petroleum springs, are, at least in certain districts, common phenomena. Salt lakes under certain circumstances afford similar indications.

Most mud volcanoes, whose history is at all complete, may be traced back to an origin essentially volcanic, although at the present time the eruption may consist only of mud, at a temperature considerably below the mean temperature at the surface. And this history is not old. Thus in Java, in Peru, and on the shores of the Caspian Sea and the Sea of Azof, either within the present century, or at least within less than a century from the present time, there have been eruptions of boiling mud, accompanied by flame blazing up to a great height and visible at a great distance. It is said that large fragments of rock have been ejected from such craters, and it is certain that many gases and great volumes of gas issue forth. At present there are only cones erupting cold mud, gases, and water.

The distribution of these phenomena is by no means irregular. They may be traced along an unbroken line of fifteen hundred miles from east to west, and they re-appear at intervals to the west, always on or near the direction of the same line. They are also near enough to volcanic phenomena of the ordinary kind to justify the belief that they are very intimately related to them. It has appeared from recent investigations that they are also near and have much relation with important springs of naphtha or petroleum, a product so important at the present day as to justify any amount of investigation that may seem likely to add to the general stock of knowledge and facilitate discovery in this matter.

The mud volcanoes that break out in the peninsula of Kertch, and are continued eastward through the peninsula of Taman, belong to an exceedingly remarkable line of volcanic

action, extending from the Putrid Sea in the Crimea to the south flanks of the Caucasus, and thence to the Caspian Sea, where in the long-celebrated naphtha springs of Baku, and the more recently known, but not less important, springs and mud volcanoes of several islands on the eastern side of the Caspian, there appear to be large and inexhaustible supplies of mineral oil, whose issue is accompanied by emanations of gas. The naphtha springs of Baku are repeated with accompanying mud volcanoes near Teflis, and the petroleum springs of the Crimea are repeated in like manner on the flanks of the Carpathians.

One of the most recent published statements of the commencement of a mud volcano, is referred to by Humboldt in the first volume of the *Cosmos*. The case is remarkable for the extraordinary height of the flames, and it occurred near Baku, in a district in which it is not unusual for columns of burning gas to be continually flaming from holes in the earth, connected with large deposits of petroleum. There is thus a relation suggested, which a further consideration of the position of mud volcanoes will, I think, show to be real and not fanciful.

I now proceed to the description of the instances recently visited by myself, or made out by careful inquiry on the spot. These localities alluded to are near the town of Kertch, in the Crimea, being within a hundred miles to the east, and the same distance to the west of that spot. The whole district occupies an interval between the Caucasus range and the mountain range of the south of the Crimea. The former is chiefly cretaceous, and culminates in the lofty mountain of Elburz, rising to the height of 18,500 feet. The latter is jurassic, and its highest point is 5185 feet. Except the Delta of the Danube, there are only the low hills of the Dobrudcha and the plains of Wallachia, between the extremity of the Crimean range and the eastern Carpathians, which rise in cretaceous peaks to nearly ten thousand feet. Mount Elburz itself is volcanic, and there is a vast development of basaltic rock a little to the south from Teflis to Mount Ararat, which as I have showed is a volcanic cone.

Although, however, the mud volcanoes are near volcanic rock, and connected in all probability with volcanic agency, they all break out in clayey and marly strata of the tertiary age. A broad tract of older, middle, and newer tertiaries, consisting of alternate bands of marl and clay, with overlying limestones often unconformable, extends uninterruptedly on the northern side of the Caucasus and the Crimean chain, occupying the whole of the vast plains so characteristic of that part of Europe and Asia. It is through faults in the clays and other lower rocks—all, however, tertiary—that the water rises charged

with various gases, and issues forth as thin fluid mud. Through the same or similar faults, rises to the surface waters loaded with sulphuretted hydrogen, such as those which give its name to the Putrid Sea; and through similar faults, generally parallel, there rises to the surface that mineral oil or petroleum which is used on a large scale in Baku and its neighbourhood, but which is perfectly available in a number of localities whence no one as yet has taken the trouble to extract it in any systematic way. Certainly the chemist is needed in these interesting spots, to enable the owners of the soil to avail themselves of the large stores of mineral wealth nature has provided; but the geologist has already made known the existence of the treasure.

The first clear and well-marked case of a mud volcano in action that came under my observation in these districts, was a few miles from Kertch, about a mile to the north of the old fortress and Turkish town of Enikale or Yenikale, a place well-known during the Crimean war, but little heard of before or since. Small wells or pits have here been dug in a white chalky rock, dipping almost vertically towards the north-east, and a spring of sulphurous water with bubbles of gas slowly but incessantly rises to the surface—these are the first things seen. These springs and wells are in a line running up from a salt marsh by the sea-side, in a direction N. 70° W. A continual gurgling noise was heard at the surface at the time of my visit, and the temperature of the water was 71° F., that of the air being some degrees lower. About one mile to the north-east of this line of springs is a line of mud volcanoes almost exactly parallel to it. Here again are both sulphur and naphtha springs, but not abundant; but close by there is a perfectly conical hill, not now erupting, and a number of lower hills, much smaller, but still of considerable size, from which mud was slowly issuing at the time of my visit.

There is something exceedingly curious in these little cones. In one of the most recent and regular, though by no means the largest, I measured a stream of thin, black, and perfectly fine and soft mud, nowhere more than a few inches in width, running slowly for a distance of about sixty yards, and falling nearly twenty feet in this distance, or about one in nine. The mud issued steadily, and at intervals of about four seconds a large bubble of gas sedately made its way to the surface and burst. This gas had neither taste nor smell. It was probably nitrogen, a gas which Humboldt had previously detected in the Crimean volcanoes. The temperature of the mud was 56°, much below that of the air at the time. This temperature agrees with that recorded as characteristic of most of the mud volcanoes of the district. A spring of water rising close by showed a temperature of 66°, and this water was sulphurous,

though not to any great extent. The mud stream very gradually became slower, as it was more distant from the vent, and ultimately tended to raise the cone, not escaping into the neighbouring valley.

Close to this vent was a crater-shaped pool of water, measuring about twenty-five paces in circumference, and through the water filling this pool large bubbles of gas were rising at the rate of about thirty-six per minute. A large conical hill is immediately adjacent. I noticed that while the mud volcanoes in action were made up entirely of the peculiar fine black marly mud emitted from the little craters, the adjacent conical hill consisted also of numerous fragments of ironstone, and some angular fragments of marly limestone, such as I observed to exist in, and be highly characteristic of, the shales through which the springs rise. They were only present in small fragments, but they were everywhere, and very abundant.

A short distance beyond, but always in the same general line, are other cones of precisely the same kind. Some are extinct and covered with vegetation, others are still bare, but not now running, and a few are pouring forth small streams of cold bubbling mud or thin paste. Of these streams a few reach the small valley below, but most of them do not reach more than a few yards, or even a foot or two. Some are just commencing, others just concluding. The whole proceeding is languid enough, but is a curious illustration of the changes going on in the earth's interior, and it has singularly modified, and even created, the chief physical features of the district.

Passing along to the west, about six miles, over a limestone hill, and through a clay valley, we come to Boulganak, where there is a large and remarkable *coulee* of mud from a cone of considerable size and height, with several smaller and newer cones close around it. Over a space, at least fifty yards in diameter, there is a bare, rugged, cracked surface of mud. Numerous similar heaps, to the number of upwards of twenty, may be counted within a narrow belt of land, about sixty yards in length. The temperature of the mud in all these cases was about 58°, or two degrees higher than at Enikale. Here, as at Enikale, I found ironstone in small fragments, and some fragments of limestone on the sides of the older cones, but none could be found amongst the mud recently erupted. The general direction of the belt is from E.N.E. to W.S.W., and petroleum springs exist in the neighbourhood.

It is certain that near this place, though not at the exact point where the mud is erupted, there are springs yielding naphtha. The naphtha, however, is independent of the mud, and not abundant. There are also sulphur springs. Some old

Tatar wells, sunk a few feet into the earth, have yielded naphtha in former times, and it is evidently the result of the experience of the Cossacks, who have been accustomed to dig for the rock oil to light their houses and cook their food, that the wells must be sunk in a line of no great breadth, generally running near that of the mud volcanoes, which is approximately W.S.W. and E.N.E., and more or less nearly parallel to it.

Still in the same direction, but ten miles beyond Boulganak, is one of a number of remarkable salt lakes, characteristic of this part of the Crimea. Its shape is roundish oval. It is separated from the Sea of Azof only by a narrow belt of sand-hills. It is only about three miles across in the widest part, and its level is some feet below that of the adjacent sea. The waters of this little lake are intensely salt, and totally different from those either of the Black Sea or the Sea of Azof. The following tabular statement will illustrate the nature of the difference. It is taken from a Russian pamphlet recently published in Odessa, by M. Haskagen of that city. The specific gravity of the Tchokrak water is stated to be 1·13807. That of Black Sea water is considerably lower than ordinary sea-water, which contains 3·4304 parts in a hundred of salts of various kinds, in solution of which two thirds are common salt, and one seventh is chloride of magnesium.

Composition of the Waters of the Black Sea and Lake Tchokrak, and of the Mud of Lake Tchokrak.

[One hundred parts of the water of the Black Sea left after evaporation 1·5258 parts, and the same quantity of Lake Tchokrak water left 14·079 parts. One hundred parts of wet mud of Lake Tchokrak, taken in its ordinary state from the shores of the lake, contained water sixty-one parts, residuum thirty-nine parts. The sixty-one fluid parts of the mud contained 12·964 parts of soluble salts and substances.]

	BLACK SEA.	TCHOKRAK WATER.	TCHOKRAK MUD.
Chloride of sodium	1·3021	6·650	5·860
Chloride of calcium	0·0179	0·120	0·095
Chloride of magnesium.....	0·0292	4·546	3·073
Iodide of sodium	0·0004	0·050	0·041
Bromide of magnesium.....	0·0008	0·008	...
Sulphate of lime.....	0·0104	0·269	0·062
Sulphate of magnesia	0·1481	2·358	2·080
Sulphate of ammonia	...	...	1·659
Organic matter and sulphur...	0·0169	0·078	0·094
	1·5258	14·079	12·964

It is impossible to examine this table without being struck by the enormous load of common salt, chloride of magnesium, and sulphate of magnesia contained in the lake waters. So great is this quantity, that for many years past it has been found advantageous to dam back the waters of this lake, and evaporate them during summer. Good common salt and abundance of Epsom salts are thus obtained; but the latter is not in sufficient demand to be of any value, and it is left in white snow-like heaps on the shore. It is thought that the annual supply of common salt is diminishing.

But although the water is remarkable enough, the mud at the bottom of the lake is still more singular. The composition of this mud taken in its ordinary state at the upper end of the lake, or that farthest from the Sea of Azof (with which, however, there is no communication whatever) is given in the table. The depth of the mud (always of the same nature) is greater than has been found possible to measure by any means attainable on the spot. It is certainly more than forty feet. The following is the composition of the insoluble part:—

Insoluble part of the Tchokrak black Mud.

Sand	35·061
Carbonate of lime	31·090
Sulphur*	9·116
Clay	19·630
Oxide of iron	9·003
Sulphate of iron	3·050
Organic matter	1·050
	100·000

The mud of this lake has very remarkable curative powers, and is said to perform cures almost miraculous in cases of scorbutic sores and chronic rheumatism. It is of the most inky blackness, and has a strong smell of sulphuretted hydrogen. The method of bathing in it is so curious as to be worth mentioning here. The patient is stripped, and lies down on his back in a kind of coarsely-made box, or coffin, partly buried in and quite filled with the mud. The mud is in a pasty state, so that the body hardly sinks in it more than into a feather-bed. When the bather has laid down in this way, an attendant heaps more mud, so as to cover completely every part but the

* The exact meaning of this I am unable to give. As I was informed it included various sulphurous substances, but chiefly sulphur. My informant, however, an intelligent Russian gentleman, was no chemist, and not familiar with either Russian or French technical terms.

face. This is all done in the open air, and a small kind of wooden parasol is so placed, as to prevent the eyes and face from being injured by the fierce burning heat of the sun. The patient thus completely buried in the black stinking mud, is left exposed to the sun for a considerable time, and soon breaks out into a profuse perspiration. It is said, that on being removed and placed in a bath of fresh water, the body is found to be much less blackened and dirtied than might be imagined. It is certain that a finger placed in the mud cannot be cleaned without much trouble. The perspiration is believed to be the cause of the difference, and there are left in the mud, after the bather has removed, small pools in the depressed parts of the moulds that seem to afford proof of this part of the efficacy of the treatment. At the time of my visit, the establishment, which consisted of a few constructions of planks, contained only two patients, but this was at the commencement of the season. I saw the *forms* or moulds of these victims after they had bathed, and they were interesting and curious enough, the whole outline and shape of the body being perfectly recognizable.

I have described the nature of the water and mud of this curious lake, because it is really of great interest in reference to the natural history of the district. The lake in question is, I believe, one of the results of the peculiar action that under some circumstances results in the formation of the crater of a mud volcano. This lake is, in fact, the connecting link between the mud volcanoes, eruptions of naphtha, saline waters, and sulphurous gases frequent near the extremity of the Crimea, and recurring in the fetid exhalations of the Putrid Sea, which are due to precisely similar causes, and which again may be traced across the southern steppes to the flanks of the Carpathians, where petroleum springs and mineral oil exist in considerable quantities.

To the south-west of the town of Kertch, at a distance of about five miles, is one large inactive cone, within a large crater, and immediately adjacent are a number of hillocks, consisting of mud erupted from mud volcanoes which are still active. A line of such hillocks extends for some miles towards the east, and a line of petroleum wells is traceable in the same direction. In one of these traces of naphtha were reached at a depth of only 17 feet from the surface. The well was sunk through clays and ironstone bands, inclined at an angle of more than 45° to N., and at a depth of about 60 feet from the surface, a large quantity of oil, apparently a steady supply, was reached at a peculiar sandstone loaded with bitumen. Other wells and borings beyond the outcrop of these sandstones, and also beyond the mud-volcano to the south, failed in getting any

supply, although the oil was several feet deep in the bottom of the first well.

In the case at present before us (Girjarva) the interest is greater than at Boulganak, inasmuch as the extinct mud-volcano, the active little craters around the oil-well, and an entire village, are all contained within the hollow of one large crater, of which one side (that to the south) is capped with limestone, from underneath whose beds springs of tolerably pure though rather saline water issue. The level of the bottom of this larger crater, which is open on one side (towards the north), and which is remarkably regular, is about 100 feet above the sea, as measured by an aneroid barometer under circumstances not very favourable. Sulphur springs come out to the south in a small valley removed from the crater by limestone hills. That the Lake Tchokrak already described is a similar crater, at a lower level, and in which the supply of water has been kept up, but which is also due essentially to volcanic agency, I have no doubt. It is only in this way, I believe, that the peculiar nature of the waters and mud can be accounted for.

Another curious and much larger lake of the same general nature, and due to similar causes, is about twelve miles south of Girjarva, and is called Tchongolek or Tobetchich. Like Tchokrak it is rounded in form; although a kind of inlet creek running to the west, in a direction opposite to the sea, gives it a peculiar form. It resembles very closely the shape of a pear. It is separated from the Black Sea by a low narrow causeway, a hundred yards or so across. The level of the small lake of Tchokrak is much lower than that of the Sea of Azof. Tchongolek is also lower than the Black Sea, but the difference is not great. Estimated by a good aneroid under favourable circumstances, it was not more than five feet. This is caused by evaporation, as there is no communication with the sea.

Like Tchokrak the waters of Tchongolek are very salt, and the mud intensely black and sulphurous. Both water and mud are somewhat less rich in products. On one part of the shore of the lake is every appearance of a crater, but the rock is here a marly limestone inclined at a very high angle (nearly 80°), and a little beyond is a string of old Tatar wells, and a number of recent sinkings and borings for petroleum. Some of the sinkings have been successful. There are salt works on this lake on a somewhat large scale, but here as at Tchokrak the sun is the only evaporative agent. Another salt lake is passed on the coast between Girjarva and Tchongolek, and there are several between the latter and Kaffa.

Crossing the Straits of Kertch we reach several low straggling fingers of land that project from the most westerly spurs of the Caucasus towards the Crimea. Between them is the

Liman or delta of the river Kuban, the principal stream draining the northern flanks of the great Caucasian chain. On all the fingers thus jutting out there are lines of elevated land, consisting almost without exception of mud volcanoes, either now active, or having very recently erupted. One of these, about 250 feet in height, is known to have erupted with much flame to a height of fifty yards above the ground. This lasted for half an hour, and was accompanied with thick black smoke; noises like thunder were heard during the eruption. Very large quantities of mud were then thrown out, but though the expression "boiling" is used with reference to the eruption, the temperature is not mentioned, and the bubbling of gas through cold mud may have been meant. The mud thus thrown out is said to have spread over the plain. The rapid eruption of mud was soon over, but subterranean noises were heard for some months. The phenomenon occurred on 27th February, 1794, and is described by the well-known naturalist Pallas. Twenty years afterwards the appearance is described by Engelhardt, who speaks of two craters, each about fifty feet in diameter, from which issued gases neither combustible nor inflammable. These gases bubbled through saltish water at a temperature of nearly 100° F. At the present time, after a further interval of rather more than half a century, this vent has almost closed up, and no knowledge or recollection of it exists among the few inhabitants of Taman, the small town on the peninsula. I had some difficulty in getting to it, although it remains a volcanic cone of great beauty, at least 250 feet above the flat plain of the delta, and possessing a crater of very distinct form. It is perfectly visible from Kertch and the Straits, and is a highly picturesque object. It is, however, not very accessible, and although close to the water, a long detour of nearly sixty miles is necessary to reach it. It has lost its characteristic names, and instead of being called "*Prekla*," or hell, by the Russians, as described by Pallas, it is now only known as "*Goréla*," or the hill. Another name, "*Kakuoba*," given in Colonel Jervis's and other good maps of the Crimea, was not recognized by any one.

Gorèla at present offers at a little distance the appearance of a perfect cone, about two miles in diameter at the base and 250 feet high. There is one opening at the south side looking towards Taman, resembling a large broken crater, and a small crater at the top with a pool of water. At the time of my visit there were marks of two or three recent *coulées* of mud, one of large size, probably within a twelvemonth, as there was no growth upon them. There were others older and now covered with vegetation. The sides of the cone consist chiefly of mud, but are covered with innumerable fragments of hard red

clayey iron oxide. There is no other cone, and no mud volcano of importance within several miles, and indeed no other on the tongue of land terminated by Goréla.

About sixteen miles east of Goréla, and on another long tongue of land to the south, on which is the small town of Taman, there is a group of mud volcanoes now very active and of considerable magnitude. The furthest of these to the east are not far from the post station and village of Aktinisorka, and, as is usually the case, there are several together, the number of actual points of eruption being few, but the evidences of recent activity plentiful enough. There are four hills extremely well-marked, ranging W.S.W., E.N.E.; each has certainly thrown out a very large quantity of mud within the last two years. The cones of mud recently erupted vary from five to twenty feet in height. From the cones actually erupting the *coulées* of mud are large, and the temperature of the mud was 56°. Numerous bubbles of gas are erupted with the mud. Here, as everywhere, I noticed fragments of red clayey ironstone and marly limestone (always angular), lying on the sides of the cones, and evidently due to the outpouring of the mud; but the mud itself as erupted was perfectly smooth, soft, and free from the smallest appreciable grit.

This group of mud volcanoes is at present very interesting. It is called Luvarka. Goréla is well seen from it, as it is the only cone at the extremity of the northern arm of the peninsula; but a chain of hills extends, occupying the middle of the strip of land forming the southern arm, and connecting with Luvarka, all of them having been formed or modified by mud eruptions. Many of these are very large, and have craters several hundred yards in diameter. Some have small detached cones, and the general elevation of the range is nearly three hundred feet. The diameter of several patches of mud recently thrown out varies from a very small space to an area of at least half an acre. In the larger spaces of cracked mud there is sometimes no cone and no appearance of the point of eruption, and nothing to prove the origin but the peculiar nature of the mud itself, which is always the same, and long remains without any growth upon it. The number of points of eruption along this line of hill, nearly ten miles in length, is far too great to be counted.

Throughout the Crimea and Taman it is commonly stated, both by the Russians and the Cossacks, that the eruptions of mud from these vents are more numerous and more abundant in hot dry weather than in winter or during rain. It is also said that the bubbles of gas are more frequent at such times, so that occasionally the mud seems to boil. I found this to be the general opinion also at Kertch; but I was also told there

that when the wind blew from the north the discharge of mud was greatest, and that when there was west wind more petroleum was obtained from the wells.

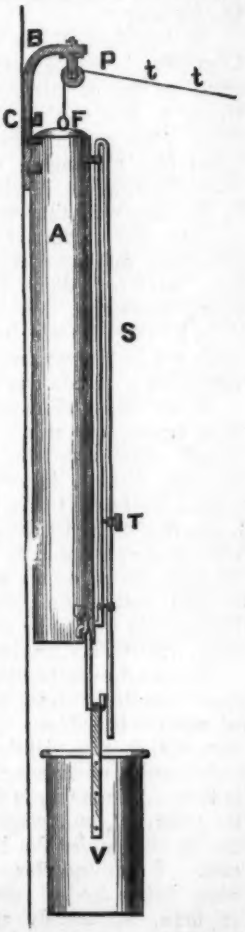
Besides the mud volcanoes and salt lakes already described, a number of other salt lakes exist at various places round the eastern part of the Crimea, both on the Sea of Azof and the Black Sea. They are, indeed, repeated at intervals for a distance of many hundred miles, and in most cases the mud partakes of the peculiar qualities and properties described as characteristic of Lake Tchokrak. The lakes as well as the mud volcanoes occur in all cases in which I was able to examine them in the highly-inclined strata underneath, and unconformable to the limestone capping the hills. The exact age of these it is not necessary here to determine, but there is clear proof that all belong to the Tertiary period, and that the elevations and movements have been continued and repeated to the most recent times. The whole bed of the Black Sea and the Sea of Azof along the broad line containing the mud volcanoes and mineral springs, whether of water or oil, is still in a state of upheaval, as proved by numerous examples of raised beaches.

The general conclusion to be drawn from the facts here recorded is, I think, confirmatory of the opinion that mud volcanoes are due to causes not different in their nature from ordinary volcanoes, though far less powerful in degree. This is fully borne out by the condition of the *salses* of Central Italy. In all of them volcanic forces of other kinds, and of greater intensity, are, or have recently, been active in the immediate neighbourhood. In some, as in the Crimea, there is still a certain amount of force tending to upheave large tracts. But it may still remain a question whether volcanic eruptions, exhibited only by the thrusting out of slow torrents of cold mud, are due to local causes, or are deep-seated and central. I think the facts (1) that the volcanic axis is identical with the great elevation axis; (2) that the axis of the smallest and most recent action of mud volcanoes is, in like manner, parallel to the most magnificent and important movements that have affected the surface of the globe; (3) that chemical changes and results, mineral waters, naphtha, and eruptions of various gases, are all connected very directly with similar lines of action; and (4) that lines of fault, mineral veins, and certain systematic changes that take place in the interior of the earth—are all sufficiently indicative of a general causation, and afford satisfactory evidence that continuous slow steady action in certain definite lines is the law of nature, though occasional outbursts and disturbances, comparatively very small, are also consistent with this grand and majestic progress.

A CLEPSYDRA FOR DRIVING TELESCOPES.

BY FREDERICK BIRD.

THE instrument of which a sketch is here given was devised by me for the purpose of imparting a slow motion to a silvered glass reflector, twelve inches aperture, mounted equatoreally. The tube is suspended on axes in a rectangular wooden frame, terminating in pivots, one of which rests in a socket embedded in stone, and the other drops into a cast-iron Y bearing. The telescope is well balanced in all positions, and moves with great freedom.



The motive power for driving, or rather drawing the telescope, resides in a column of water, containing about one and a half gallons, and placed in a cylindrical vessel, A, of zinc, three feet long, and four inches diameter. On the outside of this vessel, near the base, is inserted a small gas-tube, three-eights of an inch bore, communicating with the interior. The tube is carried up level with the top, bent sharply round, and brought down again below the base, about six inches, to form a syphon, S.

Eighteen inches from the end is inserted a stop-cock, T, to regulate the flow of water, and a vessel is placed below to receive it. At the upper end of the long vessel, A, and attached to it, is a curved iron bracket, perforated at the back, by which the whole apparatus may be hung upon a nail or hook, C, in any convenient position, if possible, within reach of the observer at the tele-

scope. The curved bracket has also inserted a pulley, P, the frame of which turns freely on its axis.

Inside the vessel A is a float, F, also made in zinc, six inches long, and three and a half inches diameter, air-tight. In the bottom of it is a disc of lead, weighing two pounds, which suffices to depress the float to the level of the water without sinking it. A fine string, *t t*, is attached to a wire loop in the float, and is carried over the pulley, and thence to the telescope.

As the force to be exerted by the float F, in moving the telescope, is not greater than that represented by its weight, some mechanical advantage may be gained by attaching the string to the end of the telescope tube, near the eye-piece, rather than to its frame, or to the polar axis. My own telescope, etc., although it weighs 250 pounds, is in this manner, when clamped in declination, drawn with the utmost facility by the float weighing only two pounds.

Since the accompanying sketch was made two conveniences have been applied which are not here shown. One of these is a "tell tale," which is drawn up outside the vessel A, by a string connecting it with the descending float; this serves to show how much water remains in the vessel. The other is a ready way of regulating the tap in the syphon-tube, when the apparatus is placed out of arm's reach, as it often may be.

It was most convenient in my own case to hang the apparatus against one side of the moveable roof of the observatory, at right angles to the opening. In this position the tap was five feet distant, immediately behind me, when at the eye-piece. To remedy this inconvenience I attached a small lever to the tap, and carried a string from it through a pulley over head in the roof, and brought it down over another pulley to the right hand of my station. By attaching an *equal weight* to either end of the string the tap could be kept open at any degree that might be required, and regulated with great precision without my leaving the eye-piece.

To put the apparatus in action let the vessel A be first placed exactly vertical, so that the float in descending may not rub against the sides; fill the vessel with water until the float rises, and is just visible at the top; suck the air out of the syphon-tube, and when the water follows turn the tap to arrest its flow. The string is then tied to the float F, brought over the pulley P, and slightly secured to the telescope. Let a star be placed in the field, and the string somewhat tightened. In doing this, the probability is, that the instrument, being pulled slightly, the star will escape out of the field, apparently eastward, if it be a reflector. The instrument may then be allowed to rest until the star re-

turns, and as soon as it gets fairly into the field, the tap of the syphon must be turned, causing the water to flow. It may be a few seconds before the string tightens to lift the float, the weight of which has to overcome the resistance of the telescope, etc.; but when that has once taken place, and the telescope begins to follow, the regulation of the water-flow in obtaining the sidereal rate is easy. If the star has got across the field by the time the float is in full action, it is evident the pace of the telescope must be increased, in order that the star may be overtaken; and this may be instantly effected by opening the tap wider, and increasing the flow of water. When the star is overtaken, and it commences moving across the field apparently eastwards, as before, the flow must be gradually diminished, until the star is "brought up." With a very little practice, the sidereal rate may be so closely approximated to, that the star can be made to remain motionless at the centre of the field, and will, of course, continue there until the tube is exhausted of water. In a tube four inches diameter the sidereal rate is represented by a drop of one inch in four minutes and a half; and, therefore, with a tube thirty-six inches long, deducting six inches for the float, an object may be kept in the field of view 135 minutes, a period of time more than sufficient for any single observation. I need scarcely point out that the tube may be put in action again immediately by pouring all the water back into it.

I by no means intend to convey the impression that this apparatus is equal in point of convenience to a fine clock motion, but a most excellent substitute for clock motion it certainly is, and I can therefore confidently recommend it to amateurs who, having equatoreal arrangements, are destitute of a driving force. The cost of the apparatus is small, and it can be made by any tinsmith. If the foregoing description should not appear very intelligible, it will afford me pleasure to answer any questions, or even to get the apparatus made complete for any one who may wish to try it.

General Cemetery, Birmingham, Nov. 22, 1865.

ON THE WELWITSCHIA MIRABILIS, Hook, Fil.

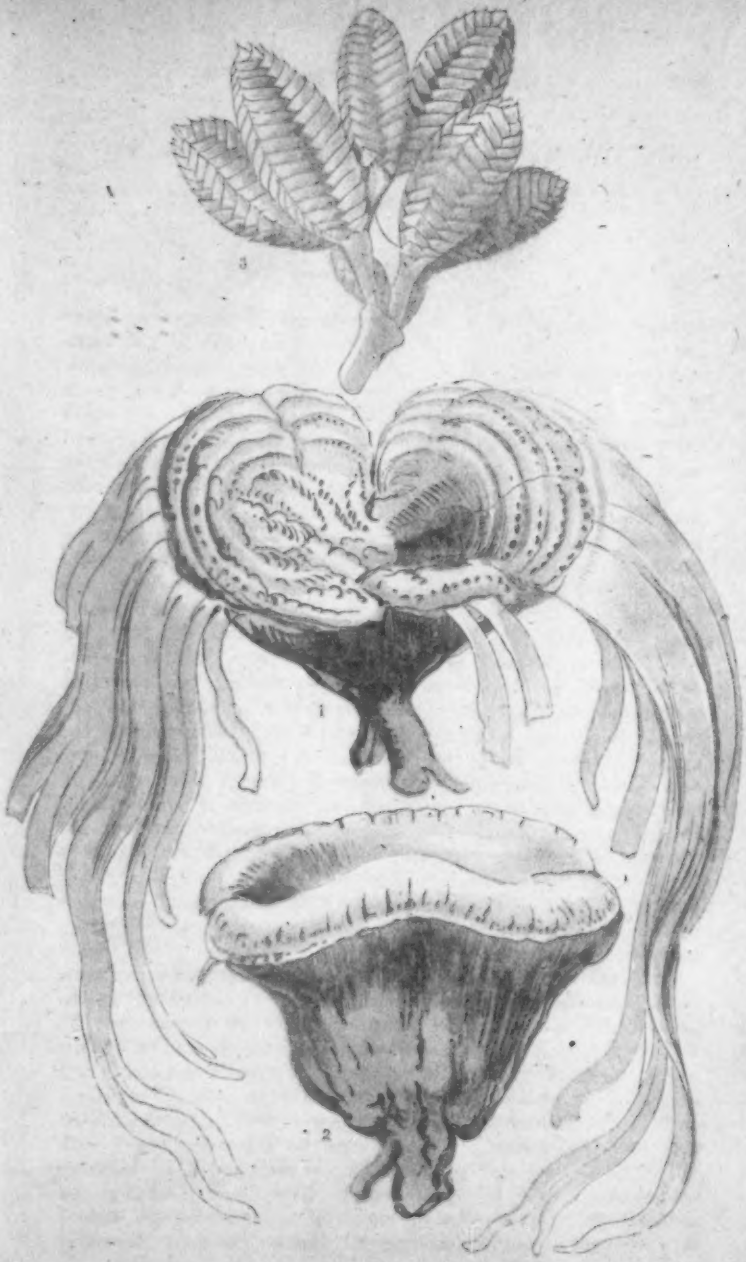
BY JOHN R. JACKSON,

Curator, Museum, Royal Gardens, Kew.

(*With a Tinted Plate.*)

In a recent number of the Intellectual Observer we gave our readers an account of the Araucarias, one of the most interesting genera of the Coniferæ. We now propose to speak of another most peculiar and interesting genus belonging to an order closely allied to that family—viz., the Gnetaceæ, or jointed firs. Seldom, if ever, has the discovery of a new plant created such an amount of interest in the scientific world as the subject of this paper. As a sensational plant, if we may so use the word, nothing has equalled it since the discovery of the gigantic parasite the *Rafflesia Arnoldii*, which so startled the savans about the year 1819. In 1860, Dr. Frederic Welwitsch, an Austrian botanist of some note, who had been exploring some of the regions of South-west Tropical Africa for some time previously, on behalf of the Portuguese Government, came upon an elevated sandy plateau about five hundred miles to the south of Cape Negro, in lat. 15° 40′ S. His attention was immediately attracted to a number of curious formations rising from a foot to eighteen inches above the surface of the ground, varying from two to fourteen feet in circumference, and having a flat, somewhat depressed top of a brown dingy colour, and appearing more like large stools or small tables than any living plant. The amazement caused by first beholding such a scene can very well be imagined; what, then, must it have been to the practised eyes of an accomplished botanist, who, upon nearing the scene, must have been pretty sure that he had alighted upon something to startle his European brethren.

Of course, Dr. Welwitsch's first proceeding was to secure a plant, and the materials for working out its scientific classification. He subsequently addressed a letter to the late Sir. W. J. Hooker, acquainting him of his great discovery. This letter, received towards the end of 1860, containing the first notice of this extraordinary plant, was immediately communicated to the Linnæan Society of London, and naturally excited an intense interest. In subsequent correspondence with Dr. Hooker on the subject, Dr. Welwitsch very liberally proposed to send his specimens to Kew for examination and publication. But twelve or eighteen months elapsed before they arrived, during which time Mr. Baines, the artist, formerly



1. Plant of Welwitschia mirabilis. Hook fil.
2. Ditto, with leaves taken off, shewing the stock.
3. Cones of Welwitschia mirabilis. Hook fil.

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attached to the Livingstone expedition, and who had since been exploring Damaraland, transmitted to Kew a case of specimens and drawings illustrating the vegetation of the country, and also some cones, which, together with the assistance of the sketches, Dr. Hooker immediately identified as those of the extraordinary plant in question. Mr. Baines would appear to have travelled after Dr. Welwitsch across the same tract of country, and there likewise to have found the plant; and, though being quite unacquainted with botanical science, but struck by the peculiar appearance, to have sketched it, and obtained some of the cones. These, however, were in such a bad state from being packed when moist, that they did not furnish sufficient evidence to found an accurate botanical description upon, and Mr. Baines's sketch was that of an artist rather than a botanist—or, as Dr. Hooker says, more artistic than scientific. Dr. Welwitsch's materials, as well as various other specimens from friends of Dr. Hooker's in that part of Africa, in answer to his letters, soon after arrived at Kew, and so fell into the best hands for a careful examination and classification. Dr. Hooker being requested by Dr. Welwitsch to undertake this task, which he did, naming the plant "Welwitschia mirabilis," in honour of its discoverer. The result of Dr. Hooker's labours was the subject of one of the most interesting papers ever read before the Linnæan Society; and in its published form, together with fourteen carefully executed plates—the expense of which was defrayed out of the annual Parliamentary grant to the Royal Society for scientific purposes—occupied one entire number of the Linnæan Society's *Transactions*.

The nature of the soil where these plants are found is sandy, hard, and parched, as little or no rain ever falls upon that part of the plain, and scarcely any other vegetation exists. Dr. Hooker, however, says, upon the authority of Mr. Galton, "that though rain never falls, the night dews are so heavy, that a small party of men, residing on the coast, is supplied thereby with water throughout the year."

As we have before said, the Welwitschia rises not more than a foot or so from the surface of the ground, and may, therefore, be called a dwarf tree. The roots which branch just below the stock penetrate several feet into the ground, and so firmly fix themselves, that it was found a very difficult matter to dig up a plant with the entire root. The point of junction between the root and the stock is, in many of the specimens, very marked. The stock in some becoming suddenly larger, or swollen at the point where the root ends, but in others it tapers off towards the root. This appears to be the case more particularly in the younger plants, and would

account for the difference in the descriptions given by Dr. Welwitsch and Mr. Monteiro, the former saying that the stem is but partially buried in the ground, while the latter describes it as being buried up to the point of attachment of the leaves. Specimens presented by both these gentlemen are in the Museum at Kew, and their appearance fully bears out both these descriptions.

The most peculiar part of this extraordinary plant is its crown, into the edges of which at the point of junction with the stock the leaves are inserted. In outline it is of an irregular oval or oblong form. The surface of this crown, and indeed the whole external part of the plant, is of a dirty brown colour, hard, rugged, and cracked, and has been aptly likened by Dr. Hooker to the crust of an overbaked loaf. This part, which is exposed more than any other to the direct rays of a tropical sun, is of course much the hardest, driest, and darkest. It is seldom or never perfectly flat, but is usually sunken towards the centre, or concave. When young, it is at first somewhat swollen here, but as the plant increases in age, it gradually sinks or contracts. From the edges or point of insertion of the leaves towards the centre, the surface is covered with little circular pits, arranged more or less in concentric ridges. These pits are the marks or scars of fallen flower-stalks. Dr. Hooker looks upon these concentric ridges as very possibly representing the annual growth of the plant. This theory, most probably, is correct, for we find that as the plant increases in age it increases much more rapidly in diameter than in height. Indeed, Dr. Welwitsch tells us that he never saw one more than twelve or eighteen inches above the ground, while they sometimes attain twelve to fourteen feet in circumference, and, it has been said, even six feet in diameter.

Another most peculiar feature is the manner in which the leaves are attached to the plant. The division of the crown from the stock is marked by a long transverse slit extending the entire length of each lobe, and it is from these slits the leaves spring.

Dr. Hooker has so clearly described this singular arrangement, that we cannot do better than give his own words. He says, "It is (the slit) nearly an inch deep in the largest specimen which I cut open; it clasps the leaf base throughout its extent when the plant is fresh; but as the latter dies its walls separate, leaving half an inch space between the upper and lower surfaces at the widest part; whether fresh or dry, its orifice is so contracted that there is very little external trace of its existence, and its lips clasp the leaf so tightly that the latter, even when detached at the base, cannot be withdrawn entire. The object of this arrangement is, no doubt, to

protect the young growing part of the leaf from the dry atmosphere."

We must now refer to the leaves themselves, which, like all other parts of the plant, whether taken in detail or on the whole, are very extraordinary. Each plant has two leaves only, corresponding in width to the lobes of the crown, and running out right and left to the enormous length of six feet, and one-twentieth of an inch in thickness. Their normal state is entire, though they are seldom, if ever, seen in that state, as they soon become split to the base into strips or thongs. They lie flat upon the ground, are of a leathery nature, and of a bright green colour, with almost imperceptible parallel veins. The stomata, or breathing cells, are placed in parallel lines, both on the upper and under sides of the leaves, which are described as being persistent during the whole life of the plant, said to be a hundred years. If this be so, which there is no reason to doubt, it is another instance of dissimilarity to most of the other members of the vegetable kingdom; for we know that the first, or cotyledonary, leaves in most plants drop off as soon as the second leaves are produced. Though none of the specimens brought to this country, or any of those seen by Dr. Welwitsch or Mr. Monteiro, had more than two leaves, Dr. Hooker says, "There is no reason why more than this number should not be developed, for the embryo may occasionally be tri or polycotyledonous, as is the case with so many other gymnosperms, including its near ally Ephedra."

We come next to speak of the fruit or cones, which, perhaps, is the only part of the plant having any general resemblance to the Coniferæ. The inflorescence is borne upon dichotomously branched cymes, which spring from the small pits or scars before spoken of upon the crown of the plant, close to the point of insertion of the leaves, and even occasionally below them. The cones, when fully grown, are about two inches long, distinctly four-sided, the sides slightly convex, and of a bright red colour. The seeds, which are contained one in each scale, are surrounded by a broad, light-coloured, transparent wing.

The Welwitschia is diœcious—that is, having its male and female flowers on separate plants. Dr. Hooker says, "I find no female cones on the same plants with the male, nor any female flowers in the hermaphrodite cones; but there are in the cymes of both sexes many imperfect cones in the axils of the permanent bracts." It is highly probable that the fertilization of the female flowers is effected by insects, as it appears "that a pollen-feeding group of Coleoptera, the Cetoniæ, abound in the regions inhabited by Welwitschia."

The season of the flowering and fruiting of the plant has not been accurately determined, inasmuch as it was found in

flower by Dr. Welwitsch in the month of September, and with ripe cones by Mr. Baines in the month of May.

From careful microscopical examination and comparison of parts, Dr. Hooker places this most extraordinary plant in the natural order Gnetaceæ, and considers it to have a very close affinity with the genera Ephedra and Gnetum.

Independently of its high scientific interest, the Welwitschia is valueless. There is no part of any economic use. Its leaves are tough, but leathery, and not softly fibrous, and therefore not adapted for cordage, weaving, or any similar use. Its trunk, though tough, is of such an uneven, fibrous grain, that the saw seems rather to tear it asunder than to cut it; and added to this, the general irregularity of its growth, it is no wonder that the plants have been allowed to grow on in their quiet, sandy desert-home, unmolested by the natives, and, in consequence, up to the time of its discovery, carefully hidden from the eye of civilized man. It is, however, one of the many proofs of the value of scientific explorations, which are happily becoming more appreciated in these days.

A NEW SPECIES OF CICADA, FROM THE CASCADE MOUNTAINS.*

BY J. K. LORD, F.Z.S.

I DISCOVERED this new and beautiful Cicada for the first time on the banks of the Pend-orielle River, on the eastern slope

* Order, *Hemiptera;* Sub-order, *Homoptera;* Fam., *Cicadidæ;* Genus, *Cicada* (Linn.); Nov. Species, *Cicada occidentalis* (Walker).

Sp. ch. Nigra subtus, albido tomentosa, facei et prothorace, testaceo marginatis, mesothorace lituris duabus cuneatis, lateribus margineque postice testaceis, segmentorum abdominalium, marginibus posticis subtus luteis, femoribus tibiisque testaceo vittatis, alis vitreis, basi rufis.

Cicada. Black under side, with shining whitish tomentum; head much narrower than the prothorax; transverse furrow in front testaceous; face transversely ridged on each side, with a testaceous border; prothorax with four oblique furrows, which converge hindward; border testaceous; sides with slightly gilded pubescence, dilated and rounded hindward; mesothorax with two V shaped testaceous marks, which extend from the fore border to the disk, and are indistinct except at the tips; sides and hind border testaceous; abdomen thinly clothed with shining whitish pubescence; hind borders of the segments luteous on each side and beneath; dorsal opercula testaceous; sheaths of the ovipositor greenish; femora and tibia with testaceous stripes; fore femora incrassated, with two teeth on the under side; wings vitreous, bright red at the base; veins black, greenish towards the base; fore wings with a greenish costa; first and second transverse veins slanting outward—first parted by more than twice its length from the second, third and fourth slightly slanting inward. Length of the body twelve lines. This species is smaller than *C. septendecem*, to which it has much general resemblance.

of the Cascade Mountains. Having fully indulged myself with a look at the scenery and a rest, after an early morning ride, I wandered off in pursuit of anything new and curious that might chance to fall in my way. Striking in among the trees, and following a deer trail for a short distance, I emerged suddenly on an open glade, or, more aptly, it may be said to have resembled an English meadow. The waving grass looked temptingly green, and peeping from amidst it were wild flowers of various species; a tiny stream, too, clear as crystal, twisted its way in many a bend and turn through this fairy spot. No human voice, perhaps, had ever disturbed its silence, but the song and twitter of birds, and the incessant hum of insect life, proclaimed at once that bush, flower, tree, rock, and lichen-clad boulder, each blade of grass, even the rippling stream, was the haunt, home, and lurking place of some living wonder.

But there was one sound—song, perhaps, I had better call it—clearer, shriller, and more singularly tuneful than any other, which never appeared to cease, and came from everywhere—from the tops of the giant pine and cedar trees, from the trembling leaves of the cotton wood, from the stunted underbrush, from the flowers, the grass, the rocks and boulders, yea, the very rivulet was vocal with these hidden minstrels, all chaunting the same refrain. It was the first time I had heard this song in north-western wilds, and although the singer was invisible, I knew it must be a cicada. A little vocalist was soon pounced upon and captured in his leafy orchestra.

Cicada Occidentalis, New Species.

He was a handsome fellow, with large bright shining eyes, and wings resembling the most delicate gauze, coloured green, and veined, like the leaves he loved to sit on. Having captured the *minstrel*, which is always the male—the female being destitute of sound-producing organs—the next thing was to commence a rigid search for female, pupa, larvæ, and eggs. The females were soon discovered clinging to the branches of the trees, some depositing their eggs, others idling amongst the foliage. They differ slightly from the males, in being less brilliantly

coloured, rather smaller, and provided with a long ovipositor, and in the absence of a sound-producing apparatus.

Turning back the long grass that grew under the shadow of the trees, lots of round holes were revealed—tortuous and winding as they deepened—and lined with a material like hardened glue, serving to preclude the access of any moisture; the greater part of those examined were generally empty; but in a few was the pupa of the cicada, quite close to the exit, or mouth of the hole. Deeper mining, aided by pick and shovel, unearthed the larvæ. I had now discovered all the family, and placing the respective living members, together with the unhatched eggs, collected from the branches of the trees, under gauze, commenced doing the detective. The situation was most convenient, and well adapted to this kind of inspection, as our depôt camp was near, and many months would have to be passed at it.

The pupa I obtained by cutting out large squares of turf and mould, in which were the holes; the larvæ, when dug up, were placed in loose earth, and supplied with fine rootlets to feed on. It will facilitate description to commence with the pupa, tracing it to the perfect insect, then how the eggs were deposited and hatched, and, lastly, what were the future proceedings of the larvæ.

When approaching maturity, the pupa remained near the surface,coming frequently to the mouth of the hole to sun itself, and get a taste of fresh air; the slightest noise, a breeze of wind, rustling the grass, a heavy cloud obscuring the sun, or a shower of rain, was quite sufficient to send it to its retreat. The pupa was in colour a yellowish brown, half cicada, half grub; the wings quite apparent, folded beneath the horny covering; the head and eyes much the same as in the mature insect. In from three to four days a few of them left their holes, and crawled up the dead branches placed in their prison (this was always accomplished during the night). As the sun shone upon the skin of the pupa, it changed into a semi-transparent condition, becoming very much lighter in colour, and in a short time, split down the entire length of the back. From out this sarcophagus crawled the winged insect; the wings damp and crumpled, and the body soft. Flowers were given them; but a sponge saturated with sugar and water, was readily and greedily sucked in preference.

Ten days passed away, and no song was attempted, and my fears were aroused lest captivity had broken the spirits, of these forest minstrels; but the real cause was soon apparent, another change of skin had to be accomplished. This was managed much in the same manner as the first shift, but attained with greater difficulty. The moisture gradually

evaporated between the body and the old skin, which at last cracked, as in the pupa, and through the rent, the whole body, wings, legs, and antennæ were drawn from their separate cases; then bidding good-bye to its old habitation, it crawled off, leaving its deserted skin clinging to the branch where the struggle took place.

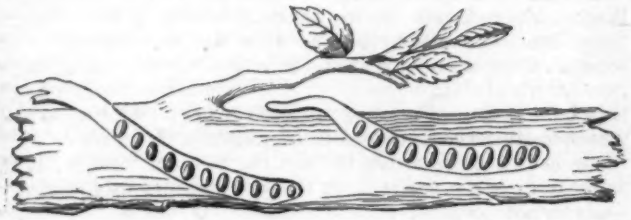
A very few days sufficed to show that the insect had attained its perfect form; the male commenced singing, and soon chose his silent wife.

The most distinctive character of this group of insects is found in the peculiar structure, by which the male is enabled to execute the shrill, prolonged, and singular music that was so prized by the ancients. These organs are situated at the base of the abdomen, and covered by two large flat plates, attached behind the place of insertion of the hind legs, but varying in form in different species, "being, in fact, the dilated sides of the metasternum" (West. Cl. In.). It is in reality a very beautifully-contrived musical instrument; there are drums and sounding-boards, with strings as tight and elastic as those of a banjo. There is also an air sac on each side of the intestinal canal, which is inflated by the opening and shutting of the wings. Connected with these sacs are valvular appendages, over which are stretched pieces of membrane, much like the skin of a banjo. The wings are always kept vibrating rapidly whenever the insect sings, striking against the drums; air at the same time being forced through the holes, or stomata, at the articulation of the wings, from the air-sacs previously spoken of —a veritable organ-pipe and bellows. Watching the cicada, whilst a prisoner, it was curious to observe its movements, prior to commencing its song. First of all the wings were opened and slowly shut, to inflate the air-sacs; then followed a gentle, vibratile movement of the wings, that increased in rapidity until they were hardly perceptible to the eye, producing the shrill song, or noise, so difficult to describe, save that it is a jubilant, joyous song, indicative of intense delight.

The eyes of *C. occidentalis* are large, prominent, and red like a ruby: between these larger eyes are three smaller ones, placed in a triangle; the antennæ six jointed; the sucker for extracting the juices of flowers composed of four pieces that form a tube, in this tube is the tonguelet, altogether a most efficient pump. Nothing can be more beautiful, or more wonderfully adapted to its purpose, than the ovipositor of the female. The instrument is concealed in a groove in the last ring of the abdomen, protected by a sheath, and consisting of three pieces. On either side are the files, on each of which are nine large teeth; at the ends, four smaller ones. The files are scooped and hollowed out, so as to fit, and work closely into the grooves,

in the central piece on each side. They are capable of being moved in any manner, separate or together, as the insect wills, the centre piece being always a fixture. The instrument is highly polished, and it is difficult to imagine that it is made up of distinct pieces, so admirably do they fit, and so rapidly is the work performed. The handles, if I may so name them, of these files, being composed of horn, afford a fixed and solid attachment for the muscles, that cause the files to be pressed closer and firmer to the centre-piece while in the act of sawing.

When the time arrived for depositing her eggs (about fourteen days after the final change), the female selected a branch from which the sap had commenced to dry up, or, in other words, which would soon decay. I observed this mode of selection more in the open forest, than during the insect's imprisonment. She first clasps the branch both sides with her legs, and with the end of the file very carefully slits up the bark, then placing the instrument longitudinally, files away, until she



Nest and Eggs of Cicada Occidentalis, magnified.

has obtained sufficient length and breadth. The *small* teeth of the files are now used crosswise of this fissure, until a trench is made in the soft pith. When large enough, slowly down the groove in the centre of the instrument glides a small, pearly egg, pointed at both ends, and so transparent, that the little grub within is easily discernible. Gently she lays it within its bed, and then drops a thin gummy material on it, to secure it from moisture. This finished, she proceeds to deposit another, and so on, until a sufficient number are produced to fill the fissure; then over all she drags the everted bark. It is easy to perceive where the cicada has been concealing her brood, by the elevations on the branch. In this manner she deposits about seven hundred eggs, going from branch to branch, her marvellous instinct teaching her to select the most suitable wood for the purpose. The time occupied in constructing each nest was from fifteen to twenty minutes. Her earthly

mission finished, she drops fainting and exhausted from the branch, and dies.

The male, who is always trilling his refrain, goes on indifferent, or unconscious, that the task of his faithful spouse is finished, singing ever, until his time comes, then he, too, drops beside her. Thus the songs, one by one, cease, not only the cicada's, but all the forest choir, and give place to the winter blasts, that sigh in mournful music through the leafless trees. These winds tear from the trees the decaying branches, which the instinct of the insect proclaimed were dying months previous. From the nests that are in these fallen branches, it is easy for the grub, the larvæ of the cicada, to bury itself in the earth, its future home; but those that come out whilst the branch remains on the tree, have to make a perilous descent. Fifty to sixty days from the time the eggs were deposited, there emerged an ugly little yellowish grub, covered with soft hair, lively and bustling; pinkish eyes, its feet armed with claws; if on the tree, they rushed directly to the end of the branch, and, without any apparent fear, precipitated themselves recklessly to the ground, where, without loss of time, they commenced digging. Their fore legs, shaped somewhat after the fashion of a mole's, enable them to turn up the ground with great expedition, ten to twelve seconds being long enough for one to get entirely out of sight. How long they remain in the larvæ condition I am unable to say.

It is a wise provision of nature that the cicada should produce such a numerous offspring; for their enemies, ever ready to pounce upon and destroy, not only the mature insect, but the eggs, larvæ, and pupa, are legion. Ants are untiring in their search for the cicada's eggs, and I have constantly observed them coming down from the trees, carrying the eggs in their mouths. Moles, too, eat the grubs during their terrestrial existence, and the brilliant Oriole, in his livery of orange and black, hunts for the insect under the leaves, nips it with its sharp beak, and descending to the ground, picks it to pieces, and, like a dainty epicure, swallows only the choicest morsels.

The Louisiana tanager seizes and gobbles him up bodily, crafty woodpeckers and stealthy little flycatchers pounce upon him in the midst of his song, and finish his life ere it is well begun. It is just possible that the female is voiceless, so as to insure greater security against the risk of capture whilst depositing her eggs.

Westwood tells us that of 150 species of cicadæ at the Royal Museum at Berlin, 70 are from America. One of the most singular of these is the *Cicada septendecem*, so named from a supposition that it only makes its appearance

once in seventeen years, a statement, the accuracy of which I am much disposed to question. All the known species of cicadæ, without an exception, as far as I know, spend only two years from the larvæ to the perfect insect, and it appears somewhat strange there should be a solitary exception to this apparently general law. Seventeen years seems an enormous time for an insect to remain in an immature condition underground. No one has ever kept the larvæ for that period of time; but because unusual numbers of cicadæ have been noticed as occurring at long intervals, it is at once assumed that seventeen years must have been spent in the larvæ state. I have never passed a summer in America without finding numerous specimens of this insect, the *red-eyed cicada*, as it is popularly styled.

The name *Cicada* is of somewhat doubtful origin. Beckman traces its derivation, *ciccum*, a thin skin; *ἄδειν*, a sound; then by others it is said to come from the Latin, *cito cadat*, short-lived, or soon to pass away. The Greeks named them *Tettix*, the French, *Chanteuses*, singers. By the Germans they are styled *Harper* (*Lierman*). Virgil, writing of the Cicadæ, deems their chaunt more loud than agreeable :—

Et cantu querulæ rumpent arbusta Cicadæ.

Widely different is the strain of a modern poet in reference to the celebrated Pineta, or Pine Forest, near Ravenna, where bards have wandered, and Cicadæ sung, from time immemorial. He writes :—

"The shrill Cicalas! people of the Pine,
Making their summer lives one ceaseless song:
There, the sole echoes, save my steeds and mine,
And vesper bells, that rose the boughs along."

BYRON.

Or, as an American writer suggests :—

"Perhaps the self-same song that found a path
Through the sad heart of Ruth, when sick for home
She stood in tears, amid the alien corn."

Homer, Virgil, Anacreon, and various ancient poets, have alike sung the praises of the Cicadæ. An Athenian banquet, without an *entrée* of Cicadas, was deemed as great a failure as would be, in these days, a Greenwich feast without whitebait. The larvæ and pupa were esteemed the greater dainties, but a female full of eggs, artistically browned, and served up hot and juicy, was a *bonne bouche* the Greek epicure well knew how to estimate. Even Aristotle thought the dish a luscious one, "*quo tempore gusta suavissima sunt*," and at the present time cicadæ are regularly sold in the markets of South America. The legs and wings are stripped off, and the body

of the insect slowly dried in the sun. When sufficiently dry, it is powdered, and made into a kind of cake, and in that form sold and eaten.

In ancient poetry and fable constant allusion is made to the cicada. The Greeks even kept the male insect in cages for the sake of its song.

It was "the nightingale of the nymphs." Anacreon says, "the Muses loved thee, Phœbus himself loves thee, and has given thee a shrill song, old age does not wear thee out, thou art wise, earthborn, and musical." The following quaint fable singularly alludes to the cicada:—"Tithonus, the son of Laomedon, was loved by Aurora, who carried him to Oelos, thence to Ethiopia, and at last to Heaven, where she prevailed on the destinies to bestow on him the gift of immortality, but forgot to add that of youth. At last Tithonus grew so old that he was obliged to be rocked to sleep, like an infant, when Aurora transformed him into a cicada, which retains its youth by changing its skin, and in its chirping retains the loquacity of old age. So also we read that Eunomus and Ariston, rival musicians, were contending against one another, each played the harp, and it was hard to say which was the better player, when crack went a string from the harp of Eunomus, a cicada pitching on the top of the instrument supplied the place of the broken string, and so effectually, that Eunomus was declared the victor.

OUR FUTURE COAL FIELDS.

BY JOHN JONES, F.G.S.,

Secretary Dudley Geological Society.

It is barely three years ago since Sir William Armstrong, in his presidential address at the Newcastle meeting of the British Association, startled the commercial community in general by his allusions to the speedy exhaustion of our British coal fields, and to the rapid approach of a period when our whole manufacturing activity must be paralyzed, or must depend upon foreign supplies of coal. The Government surveyors and other practical geologists have mapped out, with minute accuracy, almost every inch of ground belonging to that part of the great geological series known as the Coal Measures, and the number and value of the various mineral seams peculiar to each district have also been clearly ascertained.

Under these circumstances, it seems no difficult problem to determine the utmost limit of our resources of coal and

ironstone. A certain portion of each coal field has been exhausted; the produce per year is so many tons, and is constantly increasing. From these data the duration of the minerals known to exist beneath any given surface can be easily estimated with tolerable precision. If then, the calculations of so eminently practical a man as Sir W. Armstrong should be thoroughly reliable, and not overdrawn, we naturally ask what will become of the principal manufacturing industries which now contribute so largely to our national wealth and prosperity?

There is no fear that any dearth of fuel will be felt in our day, even should we have to depend entirely upon the known coal-producing areas; but if no new tracts are opened up, our descendants will, at no distant date, have to cope with a coal famine, which will speedily drive some of our most important manufactures into other localities. These were considerations which the address above-mentioned did most certainly excite in the minds of not a few practical men, and hence, since the last meeting of the British Association at Newcastle, a great amount of careful attention has been devoted to all questions by which the duration and probable extension of our coal-fields would be elucidated. The result has been the accumulation of many interesting and valuable facts, especially relative to the circumstances under which the numerous isolated coal tracts in this country were formed, and received their present configuration. A close relationship has been traced between several of these districts, and it has been pretty clearly demonstrated that a considerable portion of the Carboniferous formation is now obscured by newer deposits. To enter into details respecting all that has been done in this particular line of research would exceed the limits of this paper; but the subject is one of such national importance that we would briefly notice a few of the conclusions which have been drawn, or more fully established, from the investigations of the past few years.

In the first place, it is now the generally received opinion that all the Northern and Midland coal-fields belong to the same geological period, and were deposited originally in one extensive area, local causes producing variations in the character of the vegetable remains, in the extent of the several coal seams, and in the thickness of the intervening beds of sand and clay. This large carboniferous estuary or lake was afterwards strangely dislocated by the igneous action which produced the long line of mountain limestone and millstone grit hills now forming the Pennine range, or the backbone of England. In the gradual elevation of this central portion of the basin, the coal measures overlying the limestone would be

removed by the action of the water, while those same deposits would be only slightly affected in places remote from the centres of igneous activity, except, perhaps, to get an additional layer of matter from the denudation of the beds where elevation was progressing.

This period was succeeded by that in which the lower New Red deposits, or Permian rocks, were formed upon the edges of the coal measures. A still further obscuration of the coal would take place during the Triassic and Liassic periods; so that, doubtless, previous to the time when the Oolite was deposited, the whole or greater part of the present Northern and Midland coal-fields were completely hidden beneath a great thickness of superincumbent material. Igneous action again came into operation, and elevated particular tracts, and the Red Rocks were completely carried away by denudation, leaving large areas of Upper Carboniferous rocks exposed.

Such is a brief history of the coal-fields stretching at intervals from Fifeshire into the central part of England. Assuming then that these coal-producing areas were once connected, and that this connection still remains intact, though obscured by later formations, attention has recently been turned to the probable thickness of the Red Rocks which form the large and fertile agricultural plains of Cheshire, Shropshire, Staffordshire, and other parts of central England. Compared with these tracts, the existing coal-fields shade into insignificance, and the bare prospect of successfully following the known coal-seams beneath the Permian and Triassic systems opens up such fabulous dreams of wealth, that it is difficult to contemplate the possibility of so much good fortune with equanimity. Notwithstanding the rapidly increasing rate at which we are exhausting the coal measures of Northumberland, Yorkshire, Staffordshire, and Lancashire, we have good reason to believe that there are greater treasures in store than we have yet extracted. In the north, several mines have been sunk through the Permian beds, and coal of excellent quality has been obtained. On the western side of the Warwickshire field, similar experiments have been successfully made. The Permians adjoining South Staffordshire have been proved to over-lie the famous ten-yard seam of that coal-field. On the western border of the Coalbrookdale district, the Red Rocks have been sunk through, and coal has been found. The same has been done in Derbyshire and other places, and hence it may be considered as an established fact that we may regard the Red Sandstone plains of central England as only one great but obscured coal-field, which at no remote period will be studded with mining appliances, and will be busy with all the concomitants of a vast manufacturing district. The problems yet

to be solved are mainly these:—First, what is the maximum thickness of the Permian and Triassic systems in the districts above mentioned? At present this has not been at all accurately made out, though it is a matter of the greatest importance in arriving at a reliable estimate of the difficulties to be encountered in mining the underlying coal. In the second place, we still require additional evidence upon the precise increase of temperature which prevails at depths of from one to two thousand yards. Having due regard to the advances which have been made in our knowledge upon these points during the last few years, we may reasonably hope that in proportion as the attention of scientific men is directed to these investigations, we shall have reliable data laid down upon which the practical solution of the existence of coal underneath the tracts indicated will be easily determined, and, if discovered, will be worked with facility, though not at so cheap a rate as the mineral which lies nearer to the surface.

The immense importance of these questions is now fully admitted, especially in the Midland and Northern counties, for there some of our most important and most extensive manufactures have been established. The great hardware "village," where everything metallic is made, from a trinket to a ponderous steam-engine; the adjoining Black Country, with its extensive manufactures of iron; the potteries of North Staffordshire; the textile fabrics made in Lancashire and Yorkshire; are all dependent in a high degree upon the coal which has long been obtained close at hand. With the prospect of further supplies, which may be regarded as almost exhaustless, those manufactures will still retain their ground, nor will they show any tendency to migrate towards the West, or to any other shadowed home of future civilization and human enterprise. Of course there are numerous elements of uncertainty which ought to be taken into account when endeavouring to estimate the probable existence and value of coal measures underneath the Triassic rocks. It is just possible that the coal seams may thin out over large areas, or denudation may have removed all the upper coal measures during the interval between the close of the Carboniferous and the commencement of the Permian periods, though it is not unlikely that this latter contingency has been considerably overstated.

We may take it for granted that the mineral resources of our island are not yet even approximately known. The last quarter of a century has been exceedingly prolific in important discoveries of our natural wealth. The Northampton and Cleveland iron ores; the phosphatic deposits of North Wales, Cambridgeshire, etc.; the hæmatites of various places; and the extension of the coal-producing areas, are recent additions

to our national wealth, and we have no reason to conclude that we have exhausted our discoveries. To the rapid advancement of scientific investigation we owe nearly all that has been done in the above direction during the last few years, and we may therefore regard with confidence the researches which are still in progress. The time is, doubtless, fast approaching when the principles of natural science will be much more generally appreciated than is now the case; and if any illustration of the great practical value of such knowledge were required, it would surely be sufficient to point to the line of reasoning by which the area of our future coal fields is being now mapped out, and by which we may reasonably expect our national prosperity will be immeasurably developed.

HOT SPRINGS, AND OTHER NATURAL FEATURES OF THE PYRENEES.

BY A. S. HERSCHEL, B.A.

COVERED with a dense mass of snow, shaken with avalanches, and torn by tempests in the winter, the mountain chain of the Pyrenees no sooner recovers from its stupor, and clothes its pastures with summer green, than tourists climb its heights, ascend its plateaux, scale its lofty crags, and seek and find health and recreation among its recesses. It is not, however, to guide the reader in these scenes, but rather to describe some of the natural features of the mountains, to be found in a summer ramble among the Pyrenees, that the following few short notes are written.

Geologically speaking, the central range of the Pyrenees is a ruined wall with peaks, chiefly granite, upheaved to a height of ten or eleven thousand feet above the sea, between the low-lying plains of Languedoc on the one hand—intersected here by a canal from the Mediterranean to the Atlantic Ocean—and the high table-lands of Castile and Aragon on the other. From the spinal column of this chain, lateral spurs, like rib bones, are thrown out on either side towards the plain, composed of calcareous and other sedimentary rocks, coëval with our Greensand series, horizontally deposited, and afterwards broken up, distorted, and raised to their present elevation by the force of internal pressure. The tertiary strata at the foot of these rocks reach only to a height of a few hundred feet, and are on all hands horizontal. Extensive lower valleys between these natural buttresses branch out at their heads

into narrow ravines, leading by "ports" or mule-tracks into Spain. Others end in a natural *cul-de-sac*, called a "cinque," surrounded on three sides by lofty walls of rock, and entered by a narrow gulley from the valley on the fourth. At the head of the lower valleys lie the celebrated Pyrenean "spas," a few of which also occupy higher and cooler situations in the gorges. From valley to valley the ridges are crossed by "cols," generally lofty, and wild in their scenery—often diversified by cascades, or even by snow-drifts and mountain-lakes.

In these hill-fastnesses the box-tree is one of the most common forms of shrub, and there exists an abundant variety of wild-flowers, more like our own British flora—apparently from the neighbourhood of the Atlantic Ocean—than those met with in the more continental valleys of the Alps. A collection of specimens procured, and dried in August, 1865, occurring high and low in the Pyrenees, west of the Adour, presents us with an exactly equal proportion of British and foreign species. Those of our readers who study the pages of Linnæus and De Candolle, will meet with many familiar acquaintances in the following list:—

BRITISH SPECIES.

Common Clematis, *Clematis vitalba.*
Yellow Welsh Poppy, *Meconopsis Cambrica.*
Grass of Parnassus, *Parnassia palustris.*
St. John's Wort, *Hypericum.*
London Pride, *Saxifraga umbrosa.*
Yellow Mountain Saxifrage, *Saxifraga aïroïdes.*
Field Eryngo, *Eryngium campestre.*
Heart-leaved Valerian, *Valeriana Pyrenaïca.*
Sheep's-bit Scabious, *Jasione montana.*
Michaelmas Daisy, *Aster trifolium.*
Common Marjoram, *Origanum vulgare.*
Common Butterwort, *Pinguicula vulgaris.*

FOREIGN PLANTS.

Adonis, *Adonis Pyrenaïca.*
Alpine Columbine, *Aquilegia alpina.*
Horned Violet, *Viola cornuta.*
Alpine Pink, *Dianthus superbus.*
Silver-leafed Geranium, *Geranium argenteum.*
Broad-leafed Scabious, *Knautia sylvatica.*
Gentianella, *Gentiana acaulis.*
Viper's Bugloss, *Echium.*
Alpine Toadflax, *Linaria alpina.*
Great Self-heal, *Prunella grandiflora.*
Knot-flowered Vervain, *Verbena nodiflora.*
Auricula Primrose, *Primula auricula.*

Corresponding to the great variety of flowering plants, there is also in the Pyrenees a considerable variety of climates. At the heads of valleys between Bagnères and Pau, the well-known towns of Eaux Chaudes, Eaux Bonnes, Arrens, Barèges, St. Sauveur, and Ste. Marie, are all less than three thousand feet above the sea. Here peaches, maize, and flax reach their limits, and the vine is no longer cultivated. Above them, Gabas, Cauterets, Gavarnie, and Aragnouet, occupy the heads of gorges, at an altitude of about four thousand feet. Apples and pears arrive at maturity, oats and barley are cultivated, and eyebright, London Pride, and other familiar British flowers, are found upon the slopes. Upwards from this height to about seven thousand feet, a cloud-stratum usually occurs upon the hills, crowned with fir-forests, and at this point cultivation ceases. The banks of columbines, blue-bells, and wild mountain-pinks are left for pastures to the flocks and herds, which are guarded by a very ferocious breed of dogs. The cloud-stratum passed through, the traveller, aloft, finds himself once again in the brilliant sunshine, with the level of eternal snow around him, at an altitude of nearly nine thousand feet above the sea. Vivid-coloured iris, gentianellas, saxifrages, and other hardy flowers, at the greatest elevations, face the blinding rays of the sun, and the keen air from the surrounding snowy heights. Lammergeiers here assemble in flocks. Six of these birds were counted together, at sunrise, from the Pic du Midi de Bigorre; and one rose within gunshot before us, from the rocks on the summit of the Col du Vignemale. An ornithological fact may also be mentioned here, not altogether unconnected with the fauna of the Pyrenees. A cuckoo, evidently exhausted with its autumnal migration, was caught by hand in Jersey, on the 4th of August; and a second, equally exhausted, narrowly escaped capture in a similar manner, at Eaux Bonnes, on the 14th of the month. This probably indicates that there is a definite time for these birds to emigrate—about the first week in August—as well adhered to as that of their arrival in April.

Slight shocks of earthquakes are occasionally felt in the Pyrenees, which, although never very violent, occur at all seasons of the year. One, felt at Eaux Bonnes, and at Bajez, in the Val D'Ossau, at five o'clock on Sunday morning, the 13th of August, was not perceived at Argeles, nor at Bagnères de Bigorre, although these towns are no great distance from Eaux Bonnes. The phenomenon of earthquakes in the Pyrenees appears to be connected with the erosive action of water on the marble rocks of which a part of the range is composed, as well as with the thermal springs, of which the name in these mountains is truly legion! The town of Ax (or "Eaux," from

which the name is derived), in Ariège, numbers no less than eighty-four of these hot springs, the hottest and most copious of any in the Pyrenees. A few, like those at Bagnères de Bigorre, are purely saline. The majority are impregnated with sulphuretted hydrogen, a gas easily decomposed by contact with the air, and depositing a precipitate of sulphur, called "barégine," in open channels near their sources. The spring at Moudang contains protosulphate of iron, by which the waters preserve their sulphurous character for some time; and the waters of this spring and of a few others are exported.

The average temperature of thermal springs in the Pyrenees is more than 100° Fahrenheit, well adapted for therapeutic purposes in every variety of baths, douches, etc. The vessels for these baths are generally made of the marble of the country. That the hot springs were known to the early Romans, and were by them used for this purpose, is apparent from recent excavations at Bagnères de Bigorre, where baths have been discovered more extensive than any there existing at the present day. The question, if these thermal springs have preserved a constant temperature after the lapse of so many centuries, is one of some interest in connection with the geology of the chain. As long ago as the year 1835, Professor Forbes, of Edinburgh, specially examined their temperatures with a view to discover if any variations could be traced in a moderate number of years. In the interval now elapsed, of thirty years, many careful observations have been made, but no permanent variations have been brought to light. The most recent series of observations with which we are acquainted is that by Dr. Scoresby Jackson, in August, 1863, described in vol. xxiii., part iii., of the *Transactions of the Royal Society of Edinburgh*. By Professor Forbes the waters were examined at their source, or "griffon," as it is termed, of the spring, where the waters issue from the rock. They are conducted thence by means of various channels to the different parts of the thermal establishments, as douches, baths, etc., and to the "buvettes," which are the public fountains, where persons ordered for their health to drink the waters are supplied. At this spot a thermometer placed for a few minutes under the constantly-flowing stream, records the temperature of the water at the buvettes; but not by any means its temperature at the griffon, which is often a considerable distance from the buvette. As the rock is from time to time explored, and the buildings are improved, alterations at both sites are occasionally made. The constancy of temperature at the buvette is, however, in general, as remarkable as at the griffon of the spring itself. In Dr. Scoresby Jackson's experiments the temperatures were recorded at both places. At whatever point

of the spring the temperature of the spring is taken, the point at which the thermometer is inserted should always be accurately noted.

The instrument with which the following observations were made in August 1865 was a Centigrade thermometer, constructed by one of the best makers in Paris. The total length of the thermometer was about six inches, and the stem was engraved with sixty-six centigrade degrees. The extremity of the tube being turned into a ring, to which a cord was attached, the instrument could be completely immersed in tumblers, etc., at the springs. The words, "Rectifié, No. 795," are engraved upon the stem, and also the name and address of the person at Pau through whose kindness I received the loan of the instrument, for the purpose of making these experiments. Plunged in melting snow, and afterwards in running water in a crack of the Glacier du Vignemale, the mercury always marked within a tenth of a degree the zero of the Centigrade scale. Placed by the side of a standard thermometer in cool spring water at the residence of Mr. Maxwell Lyte, at Bagnères de Bigorre, the mercury in both instruments stood at 13° Centigrade. From these observations, and from the sensitive character of the instrument itself, it is assumed to have been free from errors of graduation. A small additive correction of between one and two-tenths of a degree Fahrenheit, for index-error, has been left out of account in the following tables.

Temperatures of five thermal springs at Cauterets in 1835, 1863, and 1865.

Name and point of Spring observed.	Temperatures, in degrees, Fahrenheit.				
	August, 1835.	August, 1863.	August, 1865.	Increase.	Decrease.
	°	°	°	°	°
La Raillière, griffon.....	101·90	101·80	...	...	0·10
Ditto buvette.....	...	101·30	101·27	...	0·03
Manhourat (en haut), buvette	121·70	121·00	120·35	...	0·65
Les Oeufs, griffon	130·10	131·00	...	0·90	...
Ditto escape	...	119·00	120·17	1·17	...
Pauze vieux, griffon	110·30	109·75	...	...	0·55
Ditto buvette.....	...	102·30	102·35	0·05	...
César (en haut), griffon...	118·10	117·40	...	...	0·70
Ditto, buvette	...	116·30	115·85	...	0·45

For convenience of comparison with the earlier observations, the indications of the Centigrade thermometer, No. 795, are

rendered, in this and the following tables, according to the ordinary rule of conversion, by their equivalents in the Fahrenheit scale. The correction of between one and two tenths of a degree Fahrenheit, to be applied additively for the index-error of the instrument, would, in general, bring the observations in August 1865 into closer coincidence with those of older dates than those already given in the table.

The spring called "Les Oeufs"—from the strong odour of rotten eggs that it emits—is the fullest, hottest, and strongest of all the springs at Cauterets. It is proposed to conduct it into the town, a distance of more than a mile from its actual source; one-half of which distance has been accomplished, and the spring now escapes from its tube by the road-side, near the Point de la Raillière. This point is apparently the point of escape described by Dr. Scoresby Jackson in 1863, and the temperature appears to have risen one degree.

The variations noticed at these springs at Cauterets in thirty years are small and insignificant when their generally high temperatures are considered. Equally small changes occur in six springs at Barèges, and at Bagnères de Bigorre, observed in August 1863 and 1865. The spring of the Platane, at Bagnères de Bigorre, of which the reservoir, or griffon, is exposed to the air, exhibits from this circumstance a somewhat more considerable alteration.

Temperatures of certain thermal springs at Barèges and Bagnères de Bigorre, in 1863 and 1865:—

Name and point of Spring observed.	Temperatures, in degrees, Fahrenheit.			
	August, 1863.	August, 1865.	Increase.	Decrease.
	°	°	°	°
1° at Barèges	...	...	...	...
Tambour, buvette	109·10	109·37	0·27	...
2° at Bagnères de Bigorre...	...	...	...	...
Platane, griffon	92·30	90·29	...	2·01
Foulon, griffon	95·00	94·97	...	0·03
La Reine, buvette	110·40	109·37	...	1·03
De la Montagne (Salut) griffon ...	89·00	90·11	1·11	...
De l'Intérieur (Salut) buvette ...	87·80	88·13	0·33	...

In the establishment of the Salut, the griffon of the "Source de la Montagne," is a horizontal gallery, driven several yards into the rock, in the floor of which the spring,

not large but deep, rises to the surface through a natural chasm in the rock. The water is conducted to the establishment, near the spring, with the least possible loss of temperature, by subterranean tubes. At the "Source de l'Intèrieur" the buvette is not more than a yard from the actual source, which is an oval recess, excavated to a depth of three feet in the rock. The normal condition of this spring, like the rest of those at Bagnères de Bigorre, is saline, but at irregular intervals it becomes sulphurous. The volume of the water at the same time enlarges. It is supposed, in explanation of this property, that water of infiltration from the surface soil, carrying with it organic matter, enters the spring, and, aided by heat, effects the decomposition of sulphate of lime and other mineral sulphates in the water, from which sulphuretted hydrogen is evolved. Alkaline sulphides, particularly sulphuret of calcium, occur among the forms in which sulphur is found in the Pyrenean springs.

At Eaux Bonnes, and at Eaux Chaudes, some interesting traces of variation are found in the observations of Professor Forbes and Dr. Scoresby Jackson. The notes of other observers tend to show, however, that these changes are not permanent, the temperatures of these springs having fluctuated several times during the short interval of thirty years, to the extent of two or more degrees. A hot spring, employed at Ax as a street fountain, has, moreover, preserved its high temperature, with only a small range from 166° to 169° Fahrenheit, unchanged for eighty years.

M. Filhol, the Head of the College of Medicine at Toulouse, who has devoted much of his personal attention to the subject, believes that, in general, springs of a high temperature are less susceptible of variations than those of a low temperature. This might naturally be expected to occur from the fact that the hottest springs have probably also the deepest source; the cooler springs, rising probably from a smaller profundity, and belonging to more permeable strata, are more exposed on this account to infiltration. In this group of variable springs, M. Filhol has observed that, with a change of temperature, there is generally a corresponding change in the volume of the water, a lower temperature being observed with an increase in the abundance of water. Nevertheless, M. Filhol has found that the temperatures of springs —even those best regulated, and most protected from water of infiltration—*is not absolutely invariable*. A diminution of temperature is sometimes observed with a diminution in the volume of the water.

Dr. Scoresby Jackson carries his conclusions further. He admits that there is perhaps, in no instance, an undevi-

ating temperature, yet he believes that the temperatures of these springs in the interior of the globe have undergone no change.

Thermal springs, it may be presumed, are caused, like other sources, by water entering the fissures of the earth at a high point, conducted thence by channels in the manner of a syphon, and seeking its issue at a lower level. Their high temperature—it has been maintained by Dr. Bianconi at Bologna—is produced by the friction of the water as it passes through its rocky channel. It may also be supposed to arise from the high temperature of the low strata of the earth into which their channels descend. If either of these suppositions is correct, the power of conducting heat that the rocks possess through which they rise must exercise a considerable influence on their temperature, in consequence of which a diminution of temperature will generally be found to accompany a diminution in the volume of the water. A diminution of temperature will also occur with an *increase* in the volume of the water, if cold surface water should, by any chance, find its way into the spring. In this way all the fluctuations of temperature and volume so frequently observed may be accounted for, without resorting to hidden agencies in the interior of the globe to explain the variations of these thermal springs. The words of Dr. Scoresby Jackson, with which he concludes his observations, appear to us to merit every attention when he says that, in these springs, "there is, perhaps, in no instance, a permanent change of temperature; but the changes observable upon the earth's surface are due to superficial and evanescent causes—such as external temperature, the infiltration of cold surface water, and the like." With these remarks we willingly leave the subject of the Pyrenean springs for the present in the hands of our readers, convinced that the inquiry in this branch of physical science, equally as in every other, will ultimately be attended with success.

A SUBSTITUTE FOR THE POSITION MICROMETER.

BY CHARLES GROVER.

[A STRONG interest attaches to the pursuit of science under considerable difficulties, and we therefore depart from our usual custom by saying a few words on the author of this communication. He is an artizan—a brushmaker—fortunately possessed of a two-inch telescope, and doing such good work with it as to have attracted honourable notice from Dr. Lee, of Hartwell House, Mr. Birt, and our own highly-esteemed contributor, the Rev. T. W. Webb, by whom this paper has been sent to us. The plan adopted by Mr. Grover is certainly ingenious, and may suggest to others, who, like him, cannot afford more perfect instruments, how much may be accomplished by ingenuity and perseverance. If a poor working man, subsisting and keeping a family upon slender weekly wages, can manage to make considerable progress in observational astronomy by the diligent employment of his leisure hours, what a wide field is open to those who can devote ample time and money to any favourite pursuit?—ED.]

I have been greatly interested in observing the various double and binary stars, so ably treated of in your pages by the Rev. T. W. Webb, and have often wished (as I dare say many other amateurs have done) for some cheap and simple instrument for measuring their angular positions, that excellent instrument, the position micrometer, being, from its price, inaccessible to me.

After a good deal of thought, and the advice of one or two astronomical friends, I have devised and constructed an apparatus which on trial I found so useful that I have thought it worth while to send you a description of it, hoping it may prove acceptable to many of your astronomical readers.

The first thing to be done is to prepare a carefully-divided circle, of a size corresponding to the eye-end of your telescope. This may be of any suitable material, to suit the amateur's convenience. Mine is simply drawn on paper, and attached to the telescope with a little warm glue. If the telescope is of small diameter, the circle may be of larger size, so as to project all round; but then it becomes liable to be injured by contact with various objects.

As to dividing, large circles have the advantage of small ones, in giving more space for division, and crowded circles are difficult to read by the faint light allowed in the observing-room. Mine is but two inches in diameter—a size not large enough to allow of single degrees being shown on it well;

FIG: 1.

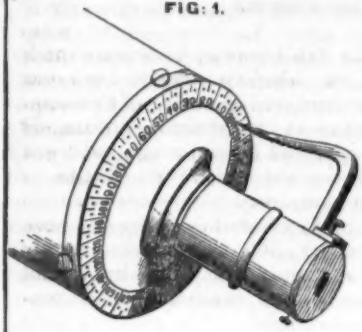


FIG: 2.

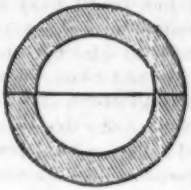


FIG: 6.

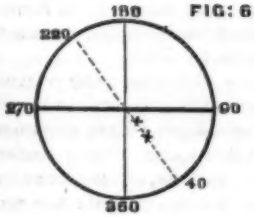


FIG: 3.

FIG: 4.

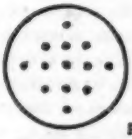


FIG: 5.

therefore it is graduated by long lines to every 10°, and shorter lines for every 5°, and by dots to 2½° (see Fig. 1).

This all-important part of the contrivance being duly attended, the index by which it is to be read next comes in for consideration. This is of steel. Its form will be more readily comprehended from the drawing than from any written description. It is attached to the eye-tube by the brass screw and nut, which is pierced with a slit lengthwise for its reception and adjustment, the length of the index being so managed that when the instrument is adjusted to focus, its point just reaches the circle. The screw on lower side of eye-tube is merely to assist in revolving the eye-piece.

Inside the eye-piece, in the focus of the eye-lens, I have fixed a perforated cardboard disc, the opening being rather larger than the aperture of the stop always placed there, and across the field a conspicuous wire is carefully placed (see Fig. 2).

Now to render this visible during observations it needs some illuminating apparatus, and I have used with advantage an oval reflector of bright tin, with a sufficient central aperture to allow all the rays from the object-glass to reach the eye unobstructed. This is fixed inside the tube, at an angle of about 45°, as shown in Fig. 3. The relative position of the screw, and the hole for admitting light, are shown in Fig. 4. This hole needs to be no larger than a sixpence, and should be just opposite the point *a*, Fig. 3. For a lantern I use a tin canister, about seven inches high, and two in diameter, with an opening in its side for light, and numerous perforations in the top for the escape of heat. Within this is a small paraffin lamp (see Fig. 5). The degree of light, and its distance and position with respect to the aperture in the telescope, will be better learnt by a few practical lessons than by any written instructions.

Having detailed the construction of the apparatus, we will now point out its use, and for this purpose we cannot do better than suppose a pair of stars in the field, as shown in Fig. 6. Now to measure their angle of position, revolve the eye-piece till the index is to the left side of the circle, and bringing the larger star to the edge of the wire, gradually revolve the eye-tube till the star in its motion through the field exactly traverses the wire. Note the degree indicated on the circle. This will be 270°. Now revolve the tube till the wire becomes parallel to the pair, and note the number of degrees it has turned, as from 270° to 220°. This is 50°; but as the smaller star is on the opposite side, the reading must likewise be transferred, and you must substract 50° from 90°, which leaves 40° for the angle.

As it is more than probable that there may be considerable errors of division in such a homely affair, it is best to take measures of an object in each of the four quadrants of the circle, as by so doing we, to a great extent, get rid of such error. Neither is it important that the points 0°, 90°, 180°, 270°, etc., should correspond to their proper places in the field, as if in the first instance just named, instead of 270°, the index read 140°, we should merely write 140°, 270°, and proceed as before. The angle made by a line joining the two stars, with the line of their motion through the field, is all that is wanted.

Professional astronomers may smile at the roughness of the contrivance; but to the amateur to whom expensive appliances are inaccessible, it will be found, when used with care and discretion, to be no mean help in the prosecution of his favourite science.

SOLAR PHYSICS.*

The physical constitution of the great centre of our system is a subject of the highest interest, not only to astronomers, but to all cultivators of natural science, and it must command the attention of all educated persons who may not specially devote their minds to scientific pursuits, just in proportion as the results arrived at admit of being placed in a popular form. England, France, and Germany are the three countries specially engaged in this question at the present time. In our own country, many private observers, like Messrs. Carrington, Lockyer, Nasmyth, Howlett, and others, have collected a highly valuable store of facts; while the Kew Observatory, taking up the previous private labours of Mr. De La Rue, has supplied, for the last two years, as far as the weather would permit, a daily record of the spots or other markings on the sun's surface which photography is able to preserve. In France, M. Chacornac works most industriously at Ville Urbanne, with—we believe—M. Foucault's large silvered glass telescope; but the *bulletins* which he is kind enough to send us do not specify either the instrument or the amount of aperture employed. We have already laid before our readers

* *Researches on Solar Physics*, by Warren De La Rue, Esq., Ph.D., F.R.S., Pres. R.A.S.; Balfour Stewart, Esq., M.A., F.R.S., Superintendent of the Kew Observatory; and Benjamin Loewy, Esq., Observer and Computer to the Kew Observatory. First Series, on the Nature of Sun-Spots. Printed for private circulation, by Taylor and Francis.

several accounts of his observations and speculations, and shall continue to do so, as they are of great value in indicating a very important class of facts, and in suggesting theories which, whether finally accepted or not, may be made of great use in suggesting particular lines of inquiry and observation. The Kew photographs, of which we gave specimens in vol. v., p. 450, afford admirable records of the appearance and disappearance of spots; but they are not intended as pictorial representations. M. Chacornac's figures possess this character, and so do the large drawings for which Mr. Howlett has won an honourable amount of fame. Several German observers contribute frequent papers to the *Astronomische Nachrichten*, and Schwabe's laborious observations, together with earlier observations by Professor Wolf, of Zurich, are amongst the materials at the disposal of Mr. Warren De La Rue and his coadjutors, who have just put forth the first series of their *Researches on Solar Physics*, of which we shall proceed to give an account.

The writers begin by remarking on the marked difference between the knowledge we possess of our luminary and of our satellite; and they say, "Could we imagine an observer suddenly transported to the neighbourhood of Tycho or Copernicus, he would probably be better prepared for the appearance presented to him than he would be if placed suddenly in equatorial Africa or central Australia." With the sun the case is different; for though the spectroscope enables us to detect the presence of certain familiar substances, the daily outpouring of solar light and heat remains a great mystery; and "it has not been finally decided whether this luminosity proceeds from the sun's solid body, or from an envelope which surrounds it. Indeed, so strange and unaccountable are many of the features presented to us, not only by our own sun, but by many of the stars, that it has even been conjectured that these bodies exhibit instances of the operation of some force of the nature of which we are yet ignorant."

In the history of solar physics, Galileo first attempted to make use of sun spots to determine the rotation of our luminary. After this, in 1777, Alexander Wilson, Professor of Astronomy in Glasgow, advanced the opinion, that the spots were cavities in a luminous photosphere. Schwabe, of Dessau, demonstrated, from forty years' observations, that "the number of spots which break out on the sun's surface is not the same from year to year, but has a maximum about every ten years—a remark which led General Sabine to observe that the various epochs of spot frequency were also those of magnetic disturbance in our own globe." To Mr. Carrington, the writers on *Solar Physics* ascribe the next important step. He

discovered that sun-spots have a proper motion of their own "those near the solar equator moving faster than those near the poles." Mr. Dawes has shown that the degrees of luminosity in the *faculæ*, or bright streaks, and spots, may be arranged as follows: 1, faculæ; 2, ordinary photosphere; 3, the penumbra; 4, the borders of the umbra; 5, the very dark central nucleus.

When the sun suffers a total eclipse, certain red flames or protuberances are noticed to surround his disc. Airy and Arago first ascribed them to the sun's disc, and "Struve showed it to be probable that these flames do not change during the moon's motion." During the Spanish expedition of 1860, Mr. De La Rue set this question at rest by showing from his photographic pictures that the moon's motion only affects these flames by covering one portion and uncovering another, and he likewise demonstrated that the angular motion of the flames corresponded with the theory of their fixation in the sun. Secchi followed De La Rue with the same results.

The "Willow Leaves" of Mr. Nasmyth are thus alluded to in *Solar Physics*:—"The evidence of these is still disputed; but some of our best observers in this country have seen them under very favourable atmospheric conditions, and they have been seen more frequently by Secchi, and other Italian observers." The important discovery by Chacornac of downward currents in the spots of which we have previously given an account, is then adverted to, as well as a similar observation by Mr. Lockyer.

In the Kew observations, reasons have been found for believing that the sun possesses an atmosphere exercising refractive power. They show the central portion of his disc to be more luminous than the borders. Kirchhoff and Bunsen's observations on solar spectra point to the same conclusion, and "the red flames which have been proved to belong to the sun indicate the existence of a solar atmosphere, extending in some instances as far as 72,000 miles above the photosphere. This is confirmed by the light which these flames emit. Mr. De La Rue has found that this light is very rich in actinic rays, so much so that he was able to photograph at least one protuberance not visible to the naked eye. Now it is precisely this description of light which characterizes the electric discharge, in which gaseous matter appears in a highly heated state."

The first question which the authors of *Solar Physics* attempt to answer is, whether the results of the observations at their disposal indicate that the umbra, or darkest part of a spot, is at a lower level than its penumbra. They give tables

analyzing many hundred observations, and show that the majority favour Wilson's supposition that the spot is a cavity with the umbra for its lowest part. Their second question is—"is the photosphere of our luminary to be viewed as composed of heavy liquid or solid matter, or is it of the nature of a cloud?" An investigation into the known appearances presented by faculæ lead them to believe that they, and indeed the whole photosphere of our luminary, are of the nature of a cloud, and they suggest the following statement: "Solar faculæ consist of solid or liquid bodies of a greater or less magnitude, either slowly sinking, or suspended in æquilibrio in a gaseous medium." The writers give elaborate tables digesting the Kew observations on the relative position of faculæ and spots, and they say that out of 1137 cases, 584 have their faculæ either entirely or mostly on the left, while 508 have it nearly equal on both sides, and only 45 mostly on the right." From this they conclude that the faculæ have been uplifted from the very area occupied by a spot, and have fallen behind to the left, from being thrown up into a region of greater velocity of rotation. They likewise give reasons for supposing that "a spot including both umbra and penumbra is a phenomenon which takes place beneath the level of the sun's photosphere."

Another important question relates to the probable comparative temperature of the darkest or lowest part of a spot. The writers accept its lower luminosity as an indication of less heat, and they conceive that a downward rush of a cold atmosphere surrounding the photosphere gives rise to the appearances that are observed. They say, "in conclusion we would venture to suggest that if the photosphere of the sun be the plane of condensation of gaseous matter, this plane may be found to be subject to periodical elevations and depressions in the solar atmosphere. It may be that at the epoch of minimum spot-frequency this plane is uplifted very high in the solar atmosphere, so that there is very little cold absorbing atmosphere above it, and therefore great difficulty in forming a spot. If this were the case, we might expect a *less* atmospheric effect, or gradation of luminosity from the centre to the circumference at the epoch of minimum than at that of maximum spot-frequency. Perhaps on some future occasion we may be able to produce evidence of this, and even of the unequal atmospheric effect of the two limbs of the sun at the same time; but in the mean time we shall content ourselves with suggesting this to the observers of our luminary as a simple inquiry that may possibly prove productive."

The scientific world is deeply indebted to Messrs. De La Rue, Stewart, and Loewy for many valuable remarks which the

first part of *Solar Physics* contains, and whatever theories may ultimately prevail, they must to a great extent be based upon, and take due account of the very large mass of carefully-assorted facts which the tables they have published present for consideration.

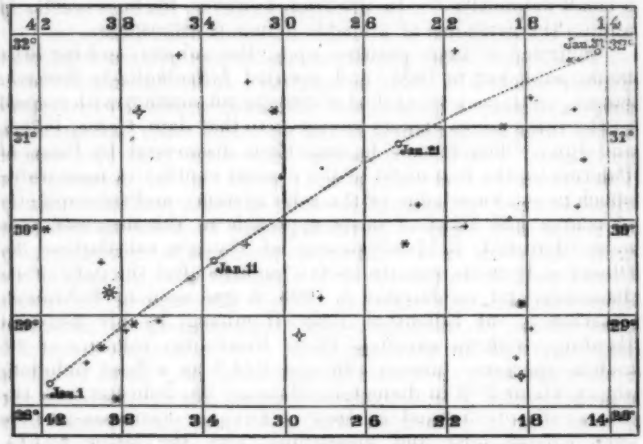
OPPOSITION OF CERES.—OCCULTATION.

BY THE REV. T. W. WEBB, A.M., F.R.A.S.

Few, probably, of our readers have seen the chief of the Minor Planets, Ceres; not so much from deficiency of brightness, at least when in a favourable part of its orbit, as from not knowing where to find it, or not having their attention directed to it. The opposition of this remarkable member of our system is now closely approaching, being calculated for January 21; and we are therefore desirous, for reasons which will soon appear, that such an opportunity for observation should not pass by unnoticed. Fortunately the planet will be situated at a considerable altitude, and in a portion of the heavens where identification will not give much trouble, as there will be a good *pointer* for the occasion, ι *Cancri*, a beautiful double star, No. 6 of our list, easily recognized by means of the instructions given in Intellectual Observer, vol. i. page 277, and the accompanying diagram, for which we are indebted to the kindness of Mr. Knott, will render it a matter of little difficulty to find the planet.

The figures at the top and bottom, it must be observed, denote minutes of R.A. in the 8th hour, those at the sides express N.D. The dotted line is the path of Ceres for the month; the large star beneath which it will pass during the first week is ι *Cancri*. This is 4·2 mag. of Argelander's scale; the others descend as far as 8·4; the planet itself ranging from 7·4 to 7·3 (or a somewhat higher rate according to Sm.'s scale). Though not visible to the naked eye, it will be readily seen, even with very small telescopes, and may be easily followed from night to night. It will, however, of course require a certain amount of aperture to detect the soft, steady character of reflected light, which will distinguish it from the flashing and sparkling aspect of the neighbouring stars; and a still greater degree of light and power will be demanded to exhibit its planetary disc, and to bring out the nebulous atmosphere by which it has been said to be surrounded, and the verification of which, if it exists, is an object of so much interest. As to the

disc, though very diminutive, and, as it seems, less sharply defined than that of the other planets, there can be no doubt of its visibility. This, as well as its reddish tinge, was established soon after its first discovery by the concurrent testimony of Hl and Schröter, and it may be perceived with smaller instruments. Smyth tells us that with the 5·9-inch aperture of his achromatic he could easily "raise" it, that is, draw it out by increase of magnifying, from the point-like appearance which, with a low power, would resemble that of a star. The nebulous envelope may be more questionable. Hl may be said to incline to its existence rather than to assert it with confidence. Thus, 1802, February 7, using a 10-ft. Newtonian reflector, aperture 8·9 inches, and power 516½, he finds "an ill-defined planetary disc, hardly to be distinguished from the surrounding haziness."



April 21, when he viewed it for nearly an hour, "there was a haziness about it resembling a faint coma, which was, however, easily to be distinguished from the body." April 22, "I see the disc of Ceres better defined and smaller than I did last night. There does not seem to be any coma." April 28, "Ceres is surrounded with a strong haziness; . . . the breadth of the coma beyond the disc may amount to the extent of a diameter of the disc, which is not very sharply defined. . . . The coma is very dense near the nucleus, but loses itself pretty abruptly on the outside, though a gradual diminution is still very perceptible." April 30, "Ceres has a visible but very small coma about it. This cannot be seen with low powers, as the whole of it together is not large enough, unless much mag-

nified, to make up a visible quantity." May 1, "The diameter of the coma of Ceres is about five times as large as the disc." 20-ft. reflector, power 477, the coma considerable. May 2, "Ceres is better defined than I have generally seen it. Its disc is strongly marked, and when I see it best, the haziness about it hardly exceeds that of the stars of an equal size." May 4, 10-ft. reflector, "I compared Ceres with two fixed stars, which in the finder appeared to be of very nearly the same magnitude with the asteroid, and found that its coma exceeds their aberration but in a very small degree. . . . 20-ft. reflector, found that the coma . . did not much exceed that of the stars. I also found that even the fixed stars differ considerably in this respect among themselves. The smaller they are, the larger in proportion will the attendant haziness show itself. A star that is scarcely perceptible becomes a small nebulosity." In drawing, however, his final result, H admits the existence of a visible nebulous atmosphere.

Schröter is more positive upon the subject, and his little book, published in 1805, and entitled *Lilienthalische Beobachtungen*, contains a good deal of curious information with respect to the three minor planets known up to that date, Ceres, Pallas, and Juno. The former, having been discovered by Piazzi at Palermo on the first night of the present century (a memorable epoch in our knowledge of the solar system), and subsequently of course lost sight of in its approach to the sun, was once more detected, in consequence of Gauss's calculations, by Olbers at Bremen, exactly twelve months after the date of its discovery, and on January 6, 1802, it was seen at Schröter's observatory, at Lilienthal, near Hamburg, by his assistant Harding, with an excellent 13-ft. Newtonian reflector of 9·5 inches aperture, powers 136 and 288,* as a faint nebulous object, about 2″·5 in diameter. January 25, Schröter saw the disc as sharply defined as that of Uranus, encompassed by a very narrow mist, and measuring, with the latter, 2″·514. January 26, it had a more nebulous outline, though in a clearer air, measuring 2″·687. January 28, much the same, well but not sharply defined, 2″·795. January 31, very ill defined, no distinct disc, though in a very clear sky, 2″·930. He now began to be struck with the regular increase in the measures. February 5, better defined than usual, and planetary-looking, though not as distinct as on January 25; measuring very satisfactorily 3″·463. February 10, the air was fine, but its

* This instrument, made by Schräder, of Kiel, in 1792, appears to have been of very superior quality; at the distance of 140 paces, the smallest print could be read with a power of 1500. Schröter employed it extensively in his lunar researches. It has been carefully preserved, and was advertised for sale two or three years ago.

aspect was very nebulous, without a distinct disc, notwithstanding the presence of bright moonlight, which, as he remarks, increases the sharpness of planetary definition, and accordingly permitted Uranus to be seen with beautiful precision. The measures gave 3″·548 for Ceres; for Uranus, which till measured had appeared evidently the larger, 3″·475. On this occasion, the remote planet's disc appeared to exceed that of the nearer one in sharpness as much as the latter surpassed that of the planetary nebula near *ν Aquarii* [I H. iv.]. February 12, bad definition, 3″·621. At this time our observers received a letter from Olbers, stating that on the 10th he had estimated the disc of Uranus at least twice as large as that of Ceres; which, in fact, might have been expected from the limited aperture of his achromatic, only $3\frac{1}{4}$ inches. A comparison of the regular increase of measures with the diminished distances of the planet from the earth (the rate of which had not been known at the time of measurement) proved that, assuming the disc to have been 2″·527 on Jan. 26, it would have amounted to only 2″·754 on Feb. 12, and hence Schröter concluded that the greater proportional increase must have been due to the increasing visibility of the exterior strata of the atmosphere during the planet's approach to the earth; as had been, he considered, the case with the comet of 1799. Feb. 18, notwithstanding a full moon, the measure amounted to 3″·048, with a cometary aspect. Mar. 5, clear evening, but no disc perceptible. Mar. 6, more distinct, and though very cometary, measuring 3″·843, whence he inferred a variable state of its own atmosphere. Uranus appeared at the same time perfectly defined, and like a miniature Jupiter without the polar flattening. Mar. 7, bad definition; 3″·965. Mar. 8, 3″·994, the brighter centre reduced by passing clouds to a much more defined disc of 3″·037. Mar. 14, disc more defined in strong moonlight, 3″·979, or in sharper glimpses, 3″·342. His most excellent 10-ft. achromatic, by P. Dollond, of $3\frac{2}{10}$ inches aperture, never showed any measurable disc or distinct coma; just as it was unable to reach, in the great nebula of Orion, many details of faint luminosity which the 13-ft. reflector showed with perfect distinctness. Opposition, Mar. 16. Mar. 20, disc more defined than recently, and brighter; somewhat exceeding even Uranus: 4″·105, and for the densest portion 3″·263. Mar. 28, 4″·021, and through flying clouds 2″·915; keeping the same proportion as before.

Here is certainly a strong case, both as regards positive nebulosity and actual magnitude, and one which would have appeared still stronger in the latter respect, if we had recounted all the precautions taken by Schröter and Harding to ensure

correct results, as well as the instances of high accuracy previously attained in the use of the same instrument—the projection-micrometer. This very simple apparatus, consisting only of a number of suitably illuminated discs, differing in size and variable in distance, among which the telescopic image is projected by the simultaneous use of both eyes, seems worthy of more attention than it has received, especially at the hands of the possessors of Newtonian reflectors, for which it is best adapted. It has much advantage in the convenience of illumination, and still more in not being sensibly affected by slight inaccuracies of workmanship or adjustment; but it requires, probably, a good deal of practice to secure ultimate correctness. But while Schröter and Harding had good reason to be satisfied with their own proceedings, a strange discrepancy in the observations on this side the water must have proved not a little annoying to them, as it certainly was startling to the astronomical world. After a very fair agreement in this respect for twenty years between the observatories of Slough and Lilienthal, Sir W. Herschel, employing the same mode of measurement, had been deducing results of marvellous contrariety with regard to the two new planets, or, as he preferred to call them, asteroids, Ceres and Pallas; allowing to the former a diameter of only 0″·351 at its mean distance, equal to about $\frac{1}{10}$ of the measure obtained at Lilienthal! "Certainly," as Schr. remarks, "never has a contrast altogether so extraordinary existed, since practical astronomy has admitted of accurate and minute measurements." The Hanoverian observer set himself, therefore, with all diligence, to examine the possible cause, and satisfied himself of the correctness of his own results by arguments which, as usual, he has worked out with painstaking copiousness of detail, but of which we can only give an outline. He remarks —and, it must be owned, with apparent justice—that a disc of such minute dimensions, shining with reflected and hazy light, could not by any possibility have been circumstantially studied by each observer with the greatest agreement as to physical aspect: that his own repeated comparisons with Uranus confirm the apparent size he assigned to Ceres: that Harding saw it as large again as the 1st satellite of Jupiter, instead of six times smaller, according to H's measure: and that on such a supposition it must have been perfectly imperceptible in the finder at Lilienthal, which, on the other hand, showed it twice as large as that satellite. An error, therefore, he believes, must have crept into H's measurements, and he proceeds to trace it. He points out the incorrectness of drawing conclusions from only the smallest (not from a mean) of three such very discordant values, 0″·40, 0″·38, and 0″·22, and found by

actual experiment that measures by the projection-micrometer could not be depended upon beyond the distance at which a good sight can read ordinary writing, such as from five to seven feet, or somewhat more: within these limits, measures at the utmost will not differ more than $\frac{1}{14}$; but at great distances, to say nothing of the attendant inconveniences, the comparison-discs appear, from irradiation, of an entirely deceptive magnitude. On looking at such a disc, placed at a distance of 178 feet, with both eyes, the left free, the right directed through a small sextant-tube without lenses, he found the image in the left eye five times larger than in the right: and the reversal of the appearance, on changing the tube to the other eye, proved the certainty of the illusion, which diminished with the distance, but did not disappear till the disc was only eight feet from the eye. And hence, as ♅ had compared Ceres with a disc at nearly 162 feet, the extraordinary discrepancy was accounted for; a conclusion which was confirmed by the circumstance, that the deviation in ♅'s measure of Pallas, with a disc placed as far as 178 feet, had been even greater than in the case of Ceres. The first suspicion of this cause of error, he says, in the recollection of his own innumerable measurements with the projection-micrometer, "made a frightful impression upon my whole soul;" from which, however, he was entirely relieved by finding that the dissimilarity wholly vanished considerably beyond the limits of such distances as he had invariably employed for twenty years. ♅ himself had, in measuring Uranus, discovered that equal comparison-discs at equal distances from the eye would appear of unequal size if unequally illuminated; and that his disc-micrometer gave the measure $\frac{1}{5}$ too small from irradiation: as indeed must naturally have resulted from his distances of 49 and 57 feet. And Schr. fully confirmed his own view, by measuring subsequently the little planet Juno with a disc at $143\frac{1}{3}$ feet; the result being 0″·50 instead of 2″·526 as given at a due distance. In addition to all this, he also urges the unsuitableness of employing magnifying powers so high as to lose the rarer parts of the nebulosity, and reduce the visible object to merely its brighter centre: and he remarks, that had the diameter of Ceres been so extremely small, its planetary light never would have been distinctly seen, as it was on Dec. 19, 1804, at a much greater distance from the earth (2·673 instead of 1·9 to 1·6), with an achromatic of scarcely two inches aperture, magnifying 21 times; nor would it, he maintains, in the 13-ft. reflector, have preserved its disc of about 1″·5 through a green glass which greatly reduced the magnitude of a brighter star; nor could it have been so much more conspicuous than Titan, to which his measures gave

a diameter of 0″·7. He therefore considers himself justified in ascribing to Ceres a diameter of about 1620 English miles, instead of the 163 of ☿; to which he would add a height of 675 miles for an atmosphere of varying density and aspect, as far as it could be traced with his 13-ft. reflector.

Such are the arguments of Schröter, in a very condensed form; and with all possible respect to the memory of one who must ever be honoured among the greatest astronomers, it must be admitted that they have a force which it is not easy to evade. It is not indeed unlikely that he may have erred in excess; but still his approximation to truth is probably much closer than that of his great rival. No subsequent measurement of Ceres seems to be recorded,* nor does it appear upon what grounds Humboldt has asserted that "the cometary clouds, in which the small planets were at first supposed to be enveloped, have disappeared on investigation with more perfect instruments." It ought, however, to be mentioned that Lamont's result with the sister planetoid Pallas, obtained with a great (11 or 12 inch?) achromatic at Munich, giving it 670 miles in diameter, instead of the 75 miles of ☿, tends strongly to confirm the view of Schröter.

We have ventured to give a large amount of detail in this instance, from an impression that this curious discussion is but little known, at least in England, and from a conviction that, with the far greater optical advantages of the present day, the true dimensions of this remarkable body, and the existence and extent of its atmosphere, might be, and ought to be, more correctly ascertained.

OCCULTATION.

Jan. 30, *a* Cancri, 4 mag., 8h. 39m. to 9h. 45m. (very nearly at the time of Full Moon).

* Prof. Stampfer of Vienna is stated to have given measurements of 39 of the Minor Planets by means of photometry, among which Ceres stands at 227 [German or English?] miles. The mode of procedure, however, can hardly lead to any satisfactory result; especially as in this instance it must involve the precarious assumption of equality of reflective power and atmospheric transparency in the objects of examination.

PLEASANT WAYS IN SCIENCE.

No. III.—Identity and Change.

To be the same, and yet different, is one of the curious problems which science presents to us. It appeals to us when we encounter the question of personal identity, and are certain that the old man passing away from us down the vale of time is the same individual that, eighty years ago, commenced his visible being under the care of nurses, who supplied the wants of infancy, enabled him to grow to childhood, to youth, to manhood, to maturity, and then to old age. All through life identity and change are exhibited to us. Each breath takes away a portion of the being that was, and brings into our organization a portion of the being that is to become; and yet we feel there is a larger and broader identity of individuality preserved throughout all these changes than can be accounted for upon any principle of discarding physical organization from our reckoning, and looking only to the spiritual essence that has pervaded and animated each stage. Whatever may be the nature or the mode of connection of mind and spirit, they seem so bound together, that all the gradations of our being may be compendiously spoken of as parts of the one enduring I.

Psychologically, the I may be conceived to begin with its own consciousness, and to endure so long as that consciousness remains. If, indeed, as some have supposed, consciousness went to sleep for ages, and then revived, only a prolonged slumber would have affected the I, and that slumber of ages might seem to it only like a momentary interruption of those processes of thought, feeling, and sensation by which we know that we exist.

We cannot look upon our physical organization as nothing more than a machine which our mind or soul plays upon like an instrument, or receives messages from like a king. It may perish while we remain. It does so perish day by day, and we do remain. The new materials take the place of old ones, but those materials which help to compose us at any moment seem to constitute a veritable and, for their time of office, an essential portion of ourselves.

Passing from conscious identity in the midst of change, let us take a survey of the lowest class of change and identity that we can conceive; and we find it beautifully illustrated in a dialogue in Oersted's *Soul in Nature*. The scene is a waterfall, and the Swedish philosopher makes one of his speakers exclaim, "You here receive an impression of the fall

of a great mass of water, which every time comes from the same enormous height, and always encounters the same obstacles. The dispersion of the drops, the foam, the sound occasioned by the fall, as well as by the roaring and foaming of the water, which always arise from the same causes, ever remain the same. In the impression which all these things produce upon us we feel a variety, but at the same time a totality; or, in other words, we feel the variety of the single impressions as the effect of one great action of nature produced by the peculiar conditions of the locality. Perhaps the invariable in this phenomenon might be termed the thought of Nature inherent in it."*

It is the peculiar function of organic nature to exhibit a higher kind of identity amid change, and the quantity of regulated and co-ordinated motion that takes place in an organism is a measure of its perfection and importance. The animal stands higher than the tree, and its various processes of growth and action are dependent upon or associated with the putting together and the taking to pieces of more complicated substances than those which constitute the great bulk of the plant. The muscular system of animals exhibits a complexity of chemical formation corresponding with its elaborate arrangement of parts. The nervous system of animals is remarkable for its chemical complexity; and no thought, feeling, or volition occurs in a living body, without a multitude of atoms undergoing oscillation and changes of place.

If we consider our globe as an individual orb, we trace again the co-existence of identity and change. In one sense, it is certainly the same globe as that on which the Mastodon trod with monster step—the same as that across the fields and lakes of which the Pterodactyl, or great flying lizard, stretched his dragon-wing—the same as that over whose morasses gigantic ferns waved their branches at one period—and in whose seas, in a remoter age, the so-called Eozoon built his complicated house. Nay, we may go further back, and accepting as probable the nebular hypothesis, we find it the same globe as that molten ball which resulted from the condensation of those thin and subtle gases that were the physical progenitors of all the structures it now contains. Whatever name it bore amongst the immortals, by that same name, bearing testimony to its identity, it may be known through all the ages of future and of ceaseless change. Its destiny may be to pass through modes of existence as different

* We quote this passage from Bohn's edition of the translation made by Leonora and Joanna Horner. We have omitted the word "*superficially*," which in the translation precedes "termed," as it can scarcely, in its ordinary acceptation, express Oersted's meaning.

from that in which we now find it, as its present form and aspect differ from the nebulous cloud, or the seething fiery ball, and it will still be what man in his day denominated the earth —but yet how changed!

Mental identity is evidenced by continued and recurring consciousness. Could we conceive a being that only thought and felt once in a thousand years, he might be as certain of his existence and of his identity as another being capable of evolving thought and becoming conscious of feeling any number of thousand times in a second. We have clocks with short pendulums, and clocks with long ones; and could we construct a chronometer with a pendulum so long, that it would require ages for the completion of its gigantic sweep, its far-separated beats would bear the same relation to each other, and testify to the identity of the instrument, as completely as does the quick and busy ticking of the little watch.

We cannot limit the time distance between the co-ordinated successions that may be comprehended under one identity, nor can we limit the space distance of portions of one great whole. In the fabric of a little ball which we can hold between our fingers incessant motions are going on, but yet the ball remains the same for its appointed time. All its particles, with all their movements, are, so to speak, under the dominion of, and are the expressions of, the same idea. The globe, with its mightier changes, has a similar identity; the solar system is *one* again in its harmonious relations—ever changing, but yet the same. May we not go further, and see a still more gigantic oneness in the entire universe, imaging the greatest oneness which man is able to conceive?

It is common, though scarcely philosophical, to speak as if each globe and system constituted an isolated existence. Modern philosophers have indeed imagined—without sufficient reason—that the sun continually receives additions to his mass in the shape of bombarding meteors, whose crash against his sides they suppose the physical cause of the renewal of his heat; and comets, in their eccentric orbits, have been thought likely to roam within the attraction of bodies powerful enough to stop their wanderings and appropriate their materials. But there is a wider supposition that seems to have the reasoning of analogy to commend it, and according to which all the matter throughout the universe is in eternal flux. Here nebulæ condense into planets, or suns; there suns and planets dissipate into nebulæ. Astronomers and physicists fill space with an ether, whose vibrations are light and heat; but if such an atmosphere of space exists, why should it be subject to vibrations only? Why should not, as some have supposed, this all-enwrapping ether-sea have its currents and its waves?

Why should not its very material be condensed in this place, and renewed or re-etherized in that? To be anything which concerns *physical* science, this ether must be a form of matter; and if so, why should not we consider it as an atmosphere common to all worlds, and possessing properties, in reference to all the host of heaven, bearing some analogy to the properties which an individual atmosphere bears to an individual globe?

In a former number of the INTELLECTUAL OBSERVER, an instrument, the "Rigid Spectroscope," an invention of Mr. Browning, was described as devised for the performance of some experiments suggested by Mr. Balfour Stewart. That able physicist wished to see whether, by moving a spectroscope from a low latitude to a high one, and thus materially changing the force of gravity, any motion, however slight, would be made in the position of certain spectrum lines. In point of fact, he wished to try whether light could be weighed. We believe the Admiralty will assist in the investigation, and that before long a ship will carry the instrument to some appropriate place. There are only two probable suppositions with respect to light, heat, and other so-called "imponderables," either that the ether whose vibrations they are supposed to be, could be weighed if apparatus of sufficient delicacy were contrived, or that gravitation is not an essential quality pertaining to matter under *all* conditions; but uniformly making its appearance under *certain* conditions. The inquiry is full of interest, and when conducted to a successful issue, will open the way to some of the widest and grandest of investigations that science has reached.

Chemistry opens before us very curious questions of identity and sameness. It shows us instances of the same substances having widely different properties in different conditions. The chemist recognizes two singular classes of bodies, the one he terms *isomeric* and the other *allotropic*. The isomeric consists of substances differing widely in appearance and properties, and yet composed of the same proportions, of the same materials. In some of these bodies the quantities of the elements are the same in actual weight, in others the proportion is kept, but the quantities may be twice as great, or even thirty times as great. The separate bodies of an isomeric series receive separate names, but allotropic bodies of the same pair or series have only one name, being considered as the same thing in two or more different states. Phosphorus is known in several states. Professor Miller says, "Phosphorus assumes several different forms under the influence of causes apparently trifling. The transparent variety when kept exposed to light under water assumes a second form, which is white and

opaque, and somewhat less fusible.* It has a specific gravity of 1·515, while phosphorus becomes reconverted into the vitreous variety by a temperature not exceeding 122°. A third form is obtained by suddenly casting melted phosphorus; it is perfectly black and opaque; while a fourth, or viscous modification, analogous to viscous sulphur, may be obtained by heating very pure phosphorus to near its boiling point, and suddenly cooling it. A fifth form occurs in the shape of red scales, which are obtained by the spontaneous sublimation of phosphorus in the Torricellian vacuum† when exposed to the rays of the sun."

This red phosphorus may be obtained by other means, and has been extensively used in the manufacture of lucifer matches, a most unhealthy business when common phosphorus is employed. It is not soluble in some liquids, like bisulphide of carbon, which dissolves common phosphorus. Instead of catching fire in the open air, as common phosphorus does at a comparatively low temperature, it must be heated to 300° before such action takes place, and instead of acting like common phosphorus as a powerful irritant poison, it may be swallowed with impunity.

It is impossible to place limits to the variety of substances that may be produced by different modes of arranging the same quantities of the same elements in various patterns. We recognize boundless diversity, but when does the identity stop? Is there only one ultimate substance capable of existing in different states? It is obvious that speculations concerning identity and change have a wide field in the regions over which chemistry presides. We have merely indicated some of the simplest, and with these for the present must be content.

The astonishing changes which animals undergo from the egg to their complete form illustrate other phases of the same theme. All creatures that we know of originate in a bud or an egg. Probably the egg always appears at some part of the series, and it is now certain that the most developed creatures, the mammalia, thus commence their being. Thus man and the silkworm both spring from eggs. In the higher forms of animals the hatching process precedes birth, in the lower the egg is born into the world, and changes take place within it which eventuate in the appearance of the infant stage of the creature that is hatched.

Natural history abounds in remarkable illustrations of the

* M. Baudrimont affirms that white phosphorus is not an allotropic form of common phosphorus, and that it only varies from the latter by having its surface corroded through partial combustion. If this be so, the general argument is not affected. M. Baudrimont's paper is in *Comptes Rendus*, 13th Nov., 1865.

† The upper and empty part of a barometer tube is a Torricellian vacuum. The air can only press up into the tube a column of mercury equal to its own weight. The tube is filled in the first instance, and the mercury falls till the air column is balanced.

diversity of appearance presented by the same animal at different stages of its existence. In the insect world we know the caterpillar, the chrysalis, and the butterfly. The young Cyclops, a well-known water flea, common in all ponds, and with which our microscopic readers must be well acquainted, differs greatly from the adult form in the shape of the body, the absence of the long tail, the want of antennæ, and many other particulars. Still more remarkable are the differences between the young crab, in shape like a helmet with a tail to it, and the adult individual, and between the young star-fish, beginning life like a painter's easel, and the full-grown form.

What constitutes the individual identity of creatures that have no continuous consciousness, or no consciousness at all, and which in their separate stages differ as much as if each stage constituted the existence of a distinct being? At one time it was thought by some philosophers that all the organs and apparatus developed in subsequent life-stages existed in the first stage in a rudimentary form. This notion is untenable. The egg-stage of animals, widely differing from each other, may be indistinguishable, and yet in each egg some special arrangement of forces and materials exists which determines the kind of development that shall ensue; and in animals that pass through many changes of form and aspect, the form that precedes is, in effect, the parent of that which is to follow.

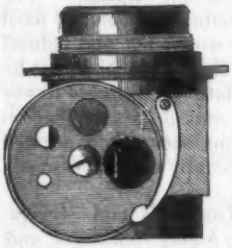
Are we to regard the seed and the plant as belonging to one individual identity. We cannot do otherwise; and in this case we have to note that from the seed the infant plant really grows, and the adult plant grows from the infant germ. The entire plant, at any one time, is continuous in its structure. But there are differences between buds and eggs, and must we take all the beings that arise from animal or vegetable buds of the same individual as partaking of its individuality? A bud may be, for example, a portion of an individual plant, and may be developed into a similar plant—aphides or plant-lice produce numerous offspring by buds as well as others at certain periods by eggs. Such cases are rather multiplications of the individual, than the production of fresh individuals.

We are accustomed to regard an animal as something complete in itself; but what shall we say when an organ of reproduction moves about as a separate thing from the creature of which it is a dissociated part? Natural history presents these curious problems. Facts of this kind have appeared, and more will appear from time to time, in our pages. They suggest profound and interesting thoughts. In this paper we have only approached the threshold of great questions. We have skimmed over a wide surface, hoping rather to stimulate inquiry in many directions than endeavouring to satisfy it in any one.

OPAQUE ILLUMINATORS FOR HIGH POWERS.

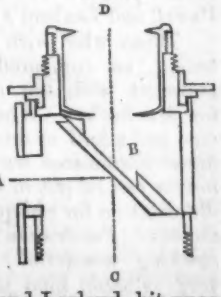
In the September number of *Silliman's Journal*, Mr. H. L. Smith, of Kenyon College, U.S., described a new illuminator he had contrived for the examination of objects under high powers by reflected light. His plan is to throw light through a lateral aperture on to a small silver reflector, so situated as to reflect the rays down through the object-glass on to the object. An instrument of this sort was recently sent by Mr. Smith to Mr. Lobb, accompanied by a request that he would invite Messrs. Powell and Lealand to make and introduce it to the English public. Those gentlemen did not read the description in *Silliman's Journal*, but, after experiment and consideration, modified Mr. Smith's plan in a way which they considered an improvement. The apparatus as made by them will be understood from the following diagrams. Fig. 1 represents its external appearance, and Fig. 2 gives a sectional view. The upper part of this apparatus screws into the body of the microscope like an adapter, and its lower part carries the object-glass. Light entering one of the round holes in the circular diaphragm strikes against a piece of glass B, which reflects a large portion of it downwards in the direction C, where the object-glass is placed. The object-glass condenses the light upon the object beneath it, and the return rays from the object pass up again through the object-glass, through the piece of glass at B, and on to the eye of the observer in the direction D.

Fig. 1.



The inclination of the piece of flat glass B is the most favourable for the reflection of the incident light down to C, and the rays on their return through the object-glass strike D at a different angle, which permits a much larger proportion to pass straight through, while another portion is reflected back again and lost.

Fig. 2.



Mr. Richard Beck, who, like Messrs. Powell and Lealand, had not seen *Silliman's Journal*, heard that Mr. Smith's plan was to throw the light down through the object-glass by means of a mirror that cut off a portion of its aperture, and he, without any concert with Messrs. Powell and Lealand, hit upon

an arrangement substantially the same as theirs. Instead of using a piece of glass with the two sides ground parallel, Mr. Beck mounted a disc of thin covering glass, so that it could be placed across the tube of his apparatus at an angle of 45°, or at such other angle as might for special purposes be desired. He did not introduce the diaphragm which Messrs. Powell and Lealand copied from Mr. Smith's pattern. Messrs. Powell and Lealand devised their plan a few days before Mr. Beck devised his, but the latter gentleman was the first to exhibit it *in public* at the last meeting of the Microscopical Society, previous to which Mr. Lobb had received their instrument from Messrs. Powell and Lealand. This rapidity in devising what to both of them was a novelty, is highly honourable to both firms; but on reference to Mr. Smith's not very clear description, it seems probable that he had tried the very same plan and rejected it as less desirable than his own. His words are, "I attempted at first to employ as the reflector a disc of the thin glass, or *two or three of them*, used as covers of microscopic objects." The words we have italicised may throw a doubt as to *how* he used the thin glass, as we cannot imagine he would put one behind the other in the same plane. He found this plan, however he carried it out, gave a field of "peculiar flatness," that is to say his objects were not in sufficient relief, and he states that on this account he preferred the unilateral illumination from a small silver mirror placed on one side, so as to occupy a position somewhat near the letter B in Fig. 2.

We have tried Messrs. Powell and Lealand's and Messrs. Smith and Beck's pattern, and both give *highly important*, and approximately good results. Neither the thin glass, nor the thicker glass with parallel sides, interfere as might be expected with the definition of high powers; on some accounts we prefer the thin glass; but it is easily broken when it requires wiping, and *very easily replaced*. The power to move the glass in Mr. Beck's plan we look upon as an advantage, and with regard to Powell and Lealand's we find their diaphragm decidedly useful.

Those who wish to study the effects of vertical illumination, as compared with oblique illumination, should experiment with the admirable reflector made by Mr. Beck for Mr. Sorby. When oblique light is wanted for powers of one and a half or one inch, or two-thirds, this is by far the finest illuminator we have tried, and in a moment a plane mirror can be put in such a position as to substitute vertical illumination for oblique. The effect is marvellous with many objects. *Penetration* is instantly lost, and every minute surface marking wonderfully shown. Thus special information of a very valuable kind is gained. When vertical illumination is applied to high powers, their penetration is much lessened, but

not lost to the *same extent* as with lower power. They have, in fact, nothing like so much to lose. The difference is in other respects the same.

The two forms of illuminator for high powers which we have described, will work, as we have found, with a fifth and with a 1-20th upon any object sufficiently flat, and possessing sufficient reflecting power. Very minute markings can be seen; but it is far from easy, if possible, to avoid the appearance of a certain milkiness in the field. Possibly—but we cannot yet say—the plan adopted by Mr. Smith may be the best, but the three plans will stand in successive positions of complexity and price. Mr. Beck's is the simplest and cheapest. Messrs. Powell and Lealand's is in some respects more complete and more costly, and when these latter gentlemen produce, as they intend doing, a more close imitation of Mr. Smith's, its complexity will be greater and its price must be proportionately higher. The subject is too new for us to be able to say more than that these reflectors are highly important inventions, which deserve the immediate attention of all careful microscopists.

PROGRESS OF INVENTION.

IMPROVEMENT IN THE PROCESS FOR OBTAINING CARBONATE OF SODA.—The economic production of carbonate of soda is of considerable importance to several of the arts and manufactures. The process invented by Leblanc for the purpose was so effective and convenient, that it has remained in use with scarcely any modifications for a long period. It consists in heating common salt with sulphuric acid; forming, by means of caustic lime, and carbonaceous matters, a mixture of caustic soda and its carbonate, from the sulphate which is obtained; dissolving these in water, to separate them from the other substances with which they are associated; evaporating the solution, and changing the caustic soda of the residual mass into a carbonate, by heating to a high temperature with sawdust; then dissolving out the salt, concentrating the solution, and crystallizing. This process has now been simplified, by decomposing the sulphate of soda obtained from common salt with caustic baryta, which throws down insoluble sulphate of barytes; and then changing the caustic soda which remains in solution into carbonate, in the ordinary way. It is probable that this method would have come into use long since, had it not been found troublesome and expensive to separate the sulphuric acid from sulphate of barytes, so as to obtain economically the required caustic barytes. Mr. Hunter has, however, overcome these difficulties, by acting on the sulphate of barytes with lime, under a pressure much more considerable than

that of the atmosphere, which he found imparted to the lime the required decomposing power.

Vision under Water.—It is easy to distinguish objects at moderate distances under water, provided the eye does not come in contact with the fluid; if it does, nothing more than a uniform mass of light is perceptible. This is very easily explained: the anterior surface of the eye forms a plano-convex lens with the water in front of it, which possesses such a dispersive effect as prevents the eye from any longer having the power of bringing the pencils of light to a focus, and forming a picture on the retina. The remedy, though apparently obvious enough, did not suggest itself until recently; it consists in counteracting the effect of the aqueous lens by means of a convex glass lens. It is clear that various forms of lens might be used for the purpose; the fact being borne in mind that, on account of the convexity of the eyeball, the concave surface of the aqueous lens has a radius of curvature scarcely greater than 0·31 of an inch. It is found, however, by calculation, that a double convex lens of flint glass, the surfaces of which have a radius of 0·48, answers the purpose; not making allowance for the peculiar kind of glass, or the adjustment required to suit the vision of different persons. A suitable lens renders objects under water distinctly visible: and it is therefore of great importance to pearl divers, collectors of sponges, and others who are obliged to operate under water, with the fluid in contact with their eyes; but it is to be observed that when it is used, the eye no longer possesses the power of adjusting itself to different distances: and hence objects cannot be seen with it at a greater distance than about three yards.

Economic Extraction of Vegetable Oils.—The oils found in various seeds, etc., have been hitherto obtained usually by means of pressure; but this is both a troublesome and a wasteful method. It has been found that any of the hydro-carbons obtained from petroleum or other mineral oils, or from asphalte, coal, slate, etc., and which boil at a temperature lower than 100° C., afford a means of extraction which is far better in every respect. The seeds, after having been bruised, are placed in a vessel which is capable of being closed hermetically, and the hydro-carbons are then introduced into the vessel. The oils are dissolved; and the solution having been run off, the hydro-carbons are removed by distillation, which is effected by means of steam that is made to pass through them, by means of a helical tube in the interior of the vessel in which the distillation is effected. Before the seeds and the hydro-carbons are brought into contact, they are slightly warmed; and the same seeds are to be acted on successively, with two or more different portions of the solvent, that the whole of the oil may be extracted.

Permanently Plastic Modelling Clay.—The rapidity with which ordinary modelling clay dries, is a source of great inconvenience to sculptors, etc.; but the difficulty arising from this circumstance may be obviated by very simple means. The fact that glycerine has no tendency to dry in atmospheric air has been already used with advantage. Its latest application consists in its employment as a means of

moistening modelling clay. The product thus obtained will possess all the good qualities of wax, but will be considerably less expensive; and it will be superior to it, in remaining of the same consistence at all temperatures. Before the glycerine is added to the clay, the latter must be well dried and pulverised. Any water left in it would subsequently destroy the plasticity; as it would pass off by evaporation, and thus leave the clay without sufficient fluid to secure to it a proper consistence.

New Mode of Producing Light for Photographic Purposes.—The discovery of the excellence of magnesium as a means of producing light has been of great advantage to the photographer; but its utility is still greatly limited by its cost, notwithstanding the improvements that have been made in the mode of obtaining it. A source of light which is very much less expensive, and which is extremely convenient, when a large mass, such as a landscape, is to be taken at night—which would require the consumption of large quantities of magnesium—has recently been discovered by M. Sayers. Twenty-four parts by weight of nitrate of potash, seven parts flowers of sulphur, and six parts red sulphuret of arsenic are thoroughly mixed. This composition, when set on fire, affords a most brilliant light; and the negatives it produces give most excellent positives. The contrast between the lights and shades, which with artificial light is liable to be very great, may be easily softened down, by igniting at once two portions of the mixture; one the more powerful, to light up the subject, and the other to modify the tones; an agreeable effect will thus be secured. It has been found that about half a pound of the mixture will afford light for half a minute—a space of time abundantly sufficient for ordinary purposes.

Further Utilization of the Aniline Dyes.—The beautiful colours derived from aniline have already received a very general application; but they have been, hitherto, unsuitable to one purpose which, of all others, would be most likely to benefit by the brilliant effects they produce—oil painting. They are now, in consequence of a recent discovery, very likely to become extremely useful in this branch of art. It has been found that a solution of aniline is capable of dissolving caoutchouc, and all the resins which have acid properties, and also the aniline dye stuffs. The application of this important fact is obvious. For example, the solution of shellac in aniline may be coloured by the addition of the concentrated solution of aniline dye stuff; the result being a transparent paint, which answers admirably for glass, porcelain, etc. This shellac solution may be mixed with any oil paints that contain no lead; and thus an oil paint of extraordinary brilliancy may be obtained. With the exception of fuschine, which, if heated with shellac, is changed to blue, all the aniline dyes may be dissolved in the aniline solution of shellac itself. When, however, fuschine is to be used, it must be dissolved in aniline without heat, and its solution then be mixed with the shellac solution.

Origin of the Staffordshire Iron Ores.—The source whence the iron ores of the Staffordshire coal measures have been derived

admits no longer of doubt. They had the same origin as the bog ores which are still being formed in the Swedish lakes: and which consist of carbonate of the protoxide, formed from hydrated peroxide by the organic matters with which these lakes abound. This important fact has been established, by a fossil belonging to the genus *Unio* having been found among these ores, and exhibiting the same constituent as they, and also the important peculiarity of belonging to a genus of mollusca, all the species of which are found exclusively in fresh water. We may infer, therefore, without hesitation, that these ores are a fresh-water formation, due to causes which, to a limited extent, are still in operation.

MISCELLANEOUS.—*Applicability of the Electric Light to Light-houses.*—The superiority of the electric light for the purpose of lighthouses has, for a considerable period, admitted of but little doubt; but the French Government seem to consider the question regarding it as now set at rest. For some time past, magneto-electric machines, with four discs, have been in use at the lighthouse of Cape de la Héve: producing a light in every way greatly superior to that obtained by the old method, and visible at the distance of twenty miles. They have now been replaced by others, having six discs; capable, when required, of giving a light equivalent to 10,000 cancel burners, or 100,000 candles, and visible at the distance of twenty-seven miles.——*Ozone.* Some important information regarding ozone has recently been obtained. The researches of M. Frêmy have led to the conclusion that our methods of detecting it in the atmosphere are not to be relied on. It is certain that the tests for ozone are similarly affected by a variety of substances, such as the oxygen compounds of azote, ammonia, formic acid, the products of combustion, and other bodies, many of which, including dust, are present in the atmosphere. He advocates the employment of silver as the reliable test; its surface being oxidized if moisture containing ozone is passed over it. Others also, and among them M. Berigny, have investigated this important subject. The researches of M. Soret have rendered it extremely probable that ozone is oxygen is an allotropic state, and having a density one and a half times that of normal oxygen. He found that when oxygen is ozonized, its volume is diminished; that when ozonized atmospheric air is acted on by iodide of potassium or other oxidizable bodies, the ozone is absorbed, but the volume is not changed; that, under the influence of heat, ozonized air so expands that the increase of volume just equals the amount of oxygen capable of uniting with iodide of potassium; and that either oil of turpentine or oil of cinnamon absorbs ozone without decomposing any of it—which is not the case with the other bodies that absorb it. He found that when ozonized oxygen is treated with oil of turpentine, the volume is diminished to an amount very nearly equal to twice that occupied by the gas absorbed by the iodide of potassium, and also to twice the increase of volume produced when the ozone is decomposed by heat.

ARCHÆOLOGIA.

CONSIDERABLE interest has just been excited in the West Riding of Yorkshire by excavations which mark either the site of the Roman town of CAMBODUNUM, or of some buildings connected with it. We have as yet, unfortunately, not very complete information on the subject, derived chiefly from the reports in local newspapers.

Cambodunum (there is no clear evidence that it is the same place which Bede calls Campodunum) appears to have been a town of importance under the Romans, and in the Itinerary of Antoninus it stands as the only place of consequence on the great road between Calcaria (*Tadcaster*) and Mamucium (apparently a mere error for Mancunium), or *Manchester*. Richard of Cirencester (a writer of at least dubious authenticity), in his Itinera, or, as it is called rather affectedly, Diaphragmata, appears to have made up this iter from Antoninus, and gives Cambodunum the same position; and in the previous part of his book he informs us it was one of the towns in Britain which enjoyed the Latian law, that is, that it was a town next in rank to a colonia. Though we have a difficulty in regarding the book which bears the name of Richard of Cirencester as anything else but a modern compilation, yet the compiler may have had some old fragments to work upon, and the rank he gives to the town of Campodunum is not at all improbable. Considerable difficulty in identifying the site of this town has arisen from evident errors in the numbers of the distances on this iter, as furnished by the manuscripts. The ignorant scribes of the Middle Ages, and no doubt many of those who preceded them, when copying manuscripts like those of the itineraries, consisting chiefly of numbers expressed in Roman numerals, leaving out an *x* or a *v*, or an *i*, or more than one, or interchanging one for the other, made so many errors, that we can never place any trust in them, and our safest evidence as to the site of a Roman town arises from finding traces on its line of road which answer to it. Such is the case with Cambodunum, which antiquaries have agreed generally in placing at Slack, in the parish of Huddersfield and township of Longwood, in Yorkshire, about four miles from Halifax. All the country round appears to be covered with traces of Roman settlements. Among the discoveries of this kind recorded, we learn that in 1743 the foundations of a Roman temple were found at Huddersfield, and, among other antiquities on the site, an altar dedicated to the goddess Fortuna, by a soldier of the sixth legion, named Antonius Modestus, which of course establishes a relationship with Eboracum, or York, which was the head quarters of this legion during the whole Roman period. In 1824, accidental discoveries were made at Slack, above mentioned, of considerable remains of Roman buildings, consisting of hypocausts, and foundations of walls. One of the tiles bore the inscription, stamped into it, COH·IIII·BRE. Camden states that this same inscription was found not uncommonly upon Roman bricks at Grimescar, near Huddersfield. It was assumed, rather hastily, by inconsiderate antiquaries, that it referred to a cohort of Britons, or even to a British

legion, which is quite inadmissible. Mr. Roach Smith, in his very valuable and already very rare volume, *Roman London*, page 116, has suggested that this inscription should be read, *Cohors quarta Breucorum*. The Breuci were a people of Pannonia, and we know that there were Pannonian auxiliaries in Britain; and then there were no doubt many people within the extent of the Roman Empire who sent bodies of auxiliary troops to Britain, of which we have at present no memorial. Since this last date there have been many discoveries of Roman antiquities over the district we are describing.

If any one of these discoveries represent the Roman Campodunum, it must of course be the one which lies upon the line of the Roman road, and on this point our information at present seems to be defective. The site on which the present excavations are being carried on is Slack, and the position, is one which might have been that of a Roman station, or of a Roman villa of importance. The present discoveries have resulted from the action of a local society, entitled the Huddersfield Archæological Association, which, under the direction of the Rev. George Lloyd, the incumbent of Thurstonland, has employed a number of men to excavate on the spot. These researches have brought to light a building sixty-eight feet in length, by sixty-four in breadth, the outer walls of which are of the usual Roman thickness of about three feet, a measure which was preserved by the mediæval builders in the walls of their houses within towns. Several internal walls were traced, inclosing a paved court. In the space between the inner paved court and the front wall of the building—we are quoting the printed description—a gold ring was found, described as "very much worn." In what appears to have been the central inner chamber, a silver coin of the Emperor Vespasian was turned up, and next day a coin of Nerva, both stated to be in a good state of preservation. Heaps of Roman pottery and bricks and tiles were collected, and among the latter some with the already well-known inscription, COH·IIII·BRE, or the fourth cohort of the Breuci, which seems to show that there was here, or in the neighbourhood, a military garrison, or, at least, a villa dependent upon one, and perhaps inhabited by its chief officer. Hypocausts were also found, and in them, among other relics, a fibula, a stone axe, and human bones. Here we have, of course, a stone implement belonging to the Roman period. In a corner of one of the hypocausts was found a large mass of metal, enveloped in wood, which at first was supposed to be silver, but, on examination, it proved to be the rich ore of lead known by the name of *galena*. It is stated that this mass weighs about 230 pounds. It would show some relationship to lead-mines or lead-works. By the side of it were found the remains of a human skeleton, and not far from it were those of a child. Whether these remains mark the site of the Roman Cambodunum, or merely those of a villa in its neighbourhood, they show that it was a military station of some importance, and that there were connected with it mining operations.

It is rather to be lamented that at a time when true and solid

archæological science has really made great advance, so many men should prefer starting theories founded upon nothing, and that so many others should throw away a great deal of ingenuity and energy upon shadowy speculations which might have been turned to good account. We have two examples before us. One is that of an inscribed OAK BEAM, or lintel, over a fire-place, in the manor keep at HEXHAM, in Northumberland. A Northumberland gentleman, with a great amount of cleverness, has made out the inscription to be Anglo-Saxon of the earlier half of the twelfth century, and gives an Anglo-Saxon reading of it, which would very much puzzle one of our Anglo-Saxon forefathers to make anything of; while any one acquainted with old English literature and manuscripts will recognize it at once as a good well-known hand of the *fifteenth* century. The inscription appears to consist chiefly of names of men. The other example to which we allude is the now rather celebrated NEWTON STONE, and its inscription. The late eminent Dr. Mill, led aside by Oriental prejudices, read it backwards and turned it into a Phœnician inscription, of an enormously early date, and revealing some most marvellous information. We see that a more recent writer, Dr. Moore, in a book upon the *Ancient Pillar Stones of Scotland*, has found out that it is in "*Arian* characters," and has given it an equally extraordinary interpretation. The stone belongs to a class of monuments well known to antiquaries, which range from perhaps as far back as the fourth or fifth centuries *after* Christ to the ninth or tenth. The original is a good deal defaced, but the first lines of it may easily be read, HIC IACIT (the usual form of the word at this period) CONSTANTINVS . . . . FILIVS . . . . The name of the father of Constantinus, and the remainder of the inscription are so much rubbed that it would require a little careful study to make it out, but we have no doubt that with this careful study it may be done.

The old acquaintance of all antiquaries, the *Gentleman's Magazine*, has just passed into new hands, and the first number of the new series will appear at the same moment with the present notice. We cannot but wish it well. The *Gentleman's* is the patriarch of English magazines. It was started so long ago as 1731, and continued as the most respectable member of the monthly periodical press for nearly a century, being then simply a journal of general literature and science. As such, it was associated with the names of Dr. Samuel Johnson and Goldsmith, and many other literary celebrities of the last century. It was, we believe, about or soon after, the year 1830, that a more especially antiquarian character was given to it, and when it passed from the house of Nichols to that of Parker, it received a stronger bias towards architectural antiquities, which of course made it rather more a class publication. The new proprietors, Messrs. Bradbury and Evans, purpose, as we understand, to restore it in some degree to its more ancient character of a general journal of literature and science. We can only say that we wish our old friend all success. We think, at the same time, that there is now a good opening for a journal, ably edited, and devoted especially to historical and antiquarian litera-

ture. Perhaps the new series of the *Gentleman's Magazine* will fill this void.

One of the BRONZE SWORDS, of which so much has been said of late, has been recently found near Rothbury, in the centre of Northumberland. It was buried in *debris* at the foot of a steep moorland hill, abounding in remains of roads, camps, etc., of apparently early date. T. W.

PROCEEDINGS OF LEARNED SOCIETIES.

BY W. B. TEGETMEIER.

GEOLOGICAL SOCIETY.—*Nov.* 22.

SELENITE IMPRESSIONS IN THE LONDON CLAY.—Mr. P. Martin Duncan read an interesting paper on the Impressions of Selenite in the Woolwich Beds and London Clay.

The spaces formerly occupied by Crystals of Selenite occur in the Woolwich Beds, near Mottingham, Kent, and in the unfossiliferous London Clay of Tendring Hundred. Mr. Duncan described the various facts bearing on the question, including the conditions under which the beds were deposited, their chemical composition, and the mineral condition of the fossils, and discussed the explanations that could be suggested to account for the formation and subsequent disappearance of the crystals. He came to the conclusion that the mineral had resulted from the action of sulphuric acid, contained in percolating water, on pre-existing carbonate of lime, the sulphuric acid having been formed by the oxidation of sulphuretted hydrogen, by the oxygen evolved from the decomposing vegetable remains occurring in the Plant-beds intercalated in the strata containing these Selenite-spaces. The hydro-carbons resulting from the same decomposition would in solution be sufficient to produce the decomposition of the Selenite. Mr. Duncan mentioned that the occurrence of Selenite in a deposit must be held to prove the former existence of organisms in it, and the removal of the Selenite to be equivalent to the loss of the evidence of such existence; consequently, there can be no reason why the purest Clay-slate may not have been once as fossiliferous as the Woolwich Beds.

GEOGRAPHICAL SOCIETY.—*Dec.* 11.

DISCOVERIES, MADAGASCAR.—Captain W. Rooke communicated an account of a boat journey along the Coast Lakes of East Madagascar, having heard, whilst at Mauritius in 1864, that the chain of lakes south of Tamatave, in Madagascar, might be traversed for several hundred miles in a boat sufficiently light to be carried over the short portages, he determined to attempt their exploration. He had a boat constructed especially for the journey, and, with three

companions and a native crew, started for the northern commencement of the lakes in the month of April. The whole journey from north to south occupied the party thirty-two days, during which they travelled nearly 400 miles, partly over lakes of larger or smaller dimensions, but chiefly along winding channels and streams which connected the lakes together. The chain of lakes and channels occupies a belt of low land along the coast, and is sometimes separated from the sea only by banks of sand. The large rivers which descend from the high lands of the interior, are connected with the network on reaching the low belt of coast land. During the journey the travellers passed numerous villages and several large towns, some of which contained about 1000 inhabitants; their voyage terminating at Manzanari. They were well received by the Hova governors; they saw very little cultivated land, and the inhabitants seemed an indolent and improvident, but good-humoured race. The banks of most of the winding channels and lakes were clothed with magnificent tropical vegetation, which in the narrow watercourses arched overhead, and added much to the beauty of the scenery. At Manzanari they saw several individuals of the Akongo tribe, whose territory lies towards the south, and who have succeeded in maintaining their independence against the Hovas. Their capital is several days' journey south-west of Manzanari, and is situated on a high hill, the sides of which have been escarped for the purposes of defence.

The Rev. W. Ellis described Ankova the central province of Madagascar, and the royal or sacred cities it contains. The country is hilly or mountainous, but the elevations rise singly or in masses, rather than form continuous chains. Mount Ankaratra, in the south-west, is one of the highest mountains in the island, being about 13,000 feet above the level of the sea. It had not yet been ascended by a European, and probably not by the natives, although they stated that in the cold season snow lay in the hollows near the summit. Between the isolated hills or mountain masses lay fertile valleys or level plains, some of them several miles in extent. The province is well watered, and the rivers, though not large, seldom fail through the long droughts of summer. Forests border the province on three sides, and supply it with abundance of valuable timber, but the central district itself is almost destitute of trees. Flowering euphorbias and fruit trees had, however, been introduced, and grew luxuriantly. Horned cattle are numerous and increasing; and it is a singular fact that, whilst the domestic ox is the humped Indian species, the vast herds of wild cattle are all of the straight-backed kind. The sacred cities of Ankova are twelve in number; they derive their sanctity from having been the birthplaces, abodes, or burial-places of their monarchs. The belief in the influence of the spirits of the ancestors of their monarchs is one of the chief features of the Malagash religion; it enters into all their most important ceremonies, and influences the actions and policy of royalty. Europeans are forbidden to enter the sacred cities; and although some of them are places of large size, they have not yet been laid down on our maps.

ZOOLOGICAL SOCIETY.—*Dec.* 12.

THE GULAR POUCH OF THE GREAT BUSTARD.—Mr. Flower, the curator of the College of Surgeons, exhibited a beautifully dissected specimen of the gular pouch of the great bustard, the *Otis tarda* of Linnæus. This pouch, which is capable of holding several pints of fluid, is situated under the skin in front of the neck, and communicates with the cavity of the mouth by an opening beneath the tongue. The use of this singular structure is very problematical, it has been stated that it is employed by the male bird for the purpose of conveying water to the female during the period of incubation, but as the males entirely desert the females at this period the explanation is evidently erroneous. In addition to the uncertainty respecting its use, the pouch of the bustard possesses a peculiar interest from the circumstance that its very existence has been denied by many naturalists, even after having been figured in many of the olden books, such as *Daniel's Rural Sports*, and even in *Yarrell's British Birds*. Messrs. Mitchell, Newton, and even Mr. Yarrell himself, in a communication made to the Royal Society, denied that such a structure existed in the specimen they dissected. It is difficult to reconcile these contradictions. It may be supposed that the pouch only is developed at certain seasons of the year, but this supposition appears untenable. Dr. Gray suggested that two distinct species had been confounded together under the same name, one possessing the pouch and the other destitute of this singular appendage.

NOTES AND MEMORANDA.

EFFECTS OF FREEZING ANIMALS.—M. Pouchet has sent a paper to the French Academy on the effects of freezing animals. He finds that no animal really frozen is susceptible of revivification, as freezing disorganizes the blood. The temperature at which the death of insects, grubs, and snails becomes inevitable, is far below the freezing point (from 7° F. to —2° F). Animals may be surrounded by ice without themselves being frozen, unless the temperature is very low. M. Pouchet states, that when an animal is frozen, the capillaries contract so as to prevent the passage of the blood, and the nuclei of the blood corpuscles escape from the envelopes, and become more opaque than in a normal state.

ANIMAL GRAFTS.—M. Paul Bert informs the French Academy of fresh experiments in grafting the tails of rats upon other rats. He finds that his curious process has succeeded after certain tails have been removed from the animals to which they belonged, and placed under the following conditions: 1. Exposed to the action of air in a closed tube for 72 hours, at a temperature of 44° to 46° F. 2. After exposure to a humid heat of 135° F. 3. After exposure to a temperature of 3° F. 4. After complete desiccation. 5. After complete desiccation, and exposure to dry heat of 212° F. The so-called "complete desiccation" was effected in *ovuo*.

COURSE OF HAIL STORMS.—M. Becquerel has a paper in *Comptes Rendus* on a chart of the hail storms in the departments of Loiret and Loire-et-Cher. The storms seem to be of two kinds, periodical and irregular, the latter being the most violent. These storms, and especially the periodical ones, follow the course of rivers and valleys, usually avoiding forests.

TEMPERATURE OF POLAR SEA.—M. Charles Martins details in *Comptes Rendus*

experiments made during the voyage of the "Recherche" to Spitzbergen, which contradict the supposed increase of temperature in the depths of the polar sea. Employing thermometers with the bulbs protected against the pressure of the water, they met with no case of the kind. He found very little difference between the temperature near the surface, and that of various depths down to 870 metres.

Consumption by Inoculation.—M. J. A. Villemin states in *Comptes Rendus* that he has in several instances produced tubercular disease in the lungs and intestines of rabbits by introducing beneath the skin of their ears small quantities of tubercular matter from a patient who died of consumption.

Solar Eclipse in Chile.—The *Astronomische Nachrichten*, No. 1555, contains a long letter from Louis Grosch, detailing observations made at Santiago de Chile during the solar eclipse, 25th April, 1865, and accompanied by a drawing. We translate the principal passages in his *resumé* of what occurred. "The greater part of the sky was covered with cirrus and stratus cloud. Before the beginning of total eclipse, the sun disappeared behind thick stratus. Before the emergence of the sun, the protuberances (red flames) appeared like a serrated border. The protuberances altered in colour from carmine to cherry red: on the moon's edge the colour was yellow. Before the bursting forth of the first sun ray, there appeared from the heretofore sharp circular moon rim, serrations with three greater projections. During the whole time of total eclipse, the dark disk of the moon was sharply defined, and only surrounded by a milk white corona. In the western part of the corona, one spot marked in the drawing was for a moment very strongly illuminated, as if a bright pencil of sunlight streamed behind the moon at this spot. The protuberances extended in a curve about 60°. The highest point of the protuberances was 0·13 of a division of the micrometer (*eines Theiles des mikrometers*). The protuberances were seen for 2½ to 3 seconds." In another passage he says, that when the coloured appearance of the protuberances vanished, thin dark projections appeared to start forth from the moon just where the protuberances were highest. Were these, he asks, lunar mountains? They appeared and vanished in a moment, and if mountains must have been of true sugarloaf form. In *Comptes Rendus*, No. 22, 1865, will be found a letter from P. Secchi, with extracts from letter of P. Capelletti, giving his observations on the eclipse of 25th April (which he dates 15th April). He writes from Conception, Chile, and says, "The first impression I received after the disappearence of the sun, was that of an immense mountain of fire, like a rose coloured horn, at 57° from the zenith towards the W." This was seen while the eclipse was total, that is for 2m. 22s. Almost diametrically opposite to it was a smaller one of the same shape, and of a somewhat lighter colour. About 38 seconds after this, coloured flames appeared, so that the sun seemed to be on fire. It looked as if a train of powder caught fire in rapid succession. This rose coloured arc was 90° broad. When the sun disappeared, three bands of light showed themselves in a direction perpendicular to the moon's border. The most luminous was so brilliant, as to dazzle the eye applied to the telescope, and in the same position as the great protuberance; with this peculiarity, that on its western side it was cut straight like a prolongation of the lunar diameter; on the other side it was bounded, not by a curve, but by an inclined line. The darkness was greater than he expected, and was increased by a fog. "An iridescent arc appeared at a distance of more than 30° from the sun, and disappeared when the eclipse ceased to be total. This arc had the form of a crescent, its extremities resting on a line tangential to the lower limb of the sun. Several stars of first and second magnitude were seen during the darkness." P. Secchi remarks on the novelty of this arc, and cannot suggest an explanation, except by supposing it due to a fog in the sun's atmosphere. With reference to the bright bands of light, he asks whether such rays may not be seen on other occasions, and he states that on the 8th August, M. Tacchini being at sea, noticed a double jet of light after sunset, which followed the sun and seemed to belong to him. On the same day, P. Secchi observed on the sun a large facula, the upper part of which was very brilliant, and terminated in two jets like two leaves, which he considers may have been the very objects seen by M. Tacchini under different circumstances.

The Classification of Mollusca.—In the *Annals of Natural History* is a paper by Dr. O. L. Morch on the "organs employed in the classification of the

Mollusca." He attaches great importance to the heart and to the organs of reproduction. He says, "The development of the young is of less systematic value than is generally believed: this is proved in the Crustaceans, the marine species having a larval form very different from the fluviatile species (*Astacus fluviatilus*, *A. Marinus*)."

Temperature at which Plants Germinate.—M. Alp. De Candolle read at the August meeting of the *Société Helvetiques des Sciences Naturelles* a paper on the above subject, detailing the results of many experiments. We extract a few particulars from the *Archives des Sciences*, No. 95. "White mustard (Sinapis alba) will germinate below 0° (the freezing point of the Centigrade scale); a flax plant (Lepodium) germinated at a mean temperature of 1°·8 C., rather more than 36° F. Collomia does not germinate below 3° C., but will do so below 5°·3 C., or just below 42° F. Nigella, Iberis, and Trifolium repens did not germinate at the last named temperature, but did at 5°·7 C. Maize germinated below 9° C. or 48°·2 F., but not below 5°·7 C. Sesamun germinated at 13° C., or 55°·4 F. Melon seed would not germinate at 13° C., but did below 17° C., or 62°·6 F. Seeds will not germinate above certain temperatures, varying with their species and the amount of moisture present; thus the greater part of some Trifolium repens seed did not germinate above 28° C., or 82°·4 F. Thus seeds only germinate between certain limits of temperature, and those which can only do so within narrow limits are least able to extend themselves geographically. Seeds of the same kind and origin will sometimes germinate in succession and not simultaneously. M. De Candolle says, that germination may be explained without any reference to "vital force," which he "leaves to the poets." The actions are, he states, "solely physical and chemical;" "the young plant in the seed, is like a prisoner confined in a small space. Physical and chemical causes enlarge the boundaries of its prison, render them flexible and permeable, and sometimes transform encumbering matter into nutritive liquids." If these operations proceed with neither too great nor too little force the plant grows.

The Temperature of Birds.—Dr. Davy has an important paper on this subject in *Proc. Roy. Soc.*, No. 78. He thinks that the respiration of birds is less active than is commonly supposed, and their high temperature is maintained by their warm clothing, and by the small loss of heat they experience through pulmonary or cutaneous evaporation, which is small in their case.

Food of Larks.—In the paper just mentioned, Dr. Davy states that he has always found grass in the gizzard of larks in the winter, and he regards it as their chief food at that season.

"The Earth in the Comet's Tail."—Our readers will recollect this was the title of a paper in our vol. i. p. 63, in which Mr. Webb furnished, from his own observations, reasons for corroborating the conclusion arrived at by Mr. Hind, that on the evening of June 30th, 1861, or a little earlier, our earth was in the tail of the comet then visible. M. Liais at the same time thought we had actually passed through the second tail of this comet. He now states, in *Comptes Rendus*, that more complete calculations confirm this belief. He computes that the axis of the second tail of the comet must have cut the earth's orbit at 6h. 12m. 10s. in the morning of the 30th June, at Rio Janeiro, and at that time he considers that we were plunged 110,000 leagues deep in the tail. From the velocity of the earth's motion he estimates that our entrance into the tail was four hours earlier. Rio Janeiro is in long. 43° 7′ 15″ west of Greenwich. M. Liais adds that if, as certain European observers thought, the tail was a little curved, we might, instead of simply passing through it, and across it, have moved for some time in the direction of its long axis. The breadth of the tail he estimates at 878,000 leagues.

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